BELL TELEPHONE QUARTERLY

VOL. XIV JANUARY, 1935

THE LONG STRUGGLE AGAINST CABLE CROSSTALK

THE LAST WORD IN TELEPHOTOGRAPHY

PRESENT-DAY HOUSING IN SIXTY-FOUR AMERICAN CITIES

THE CHANGING YEARS AS SEEN FROM THE SWITCHBOARD

INTERNATIONAL RADIO TECHNICAL COMMITTEE MEETING OF LISBON, 1934

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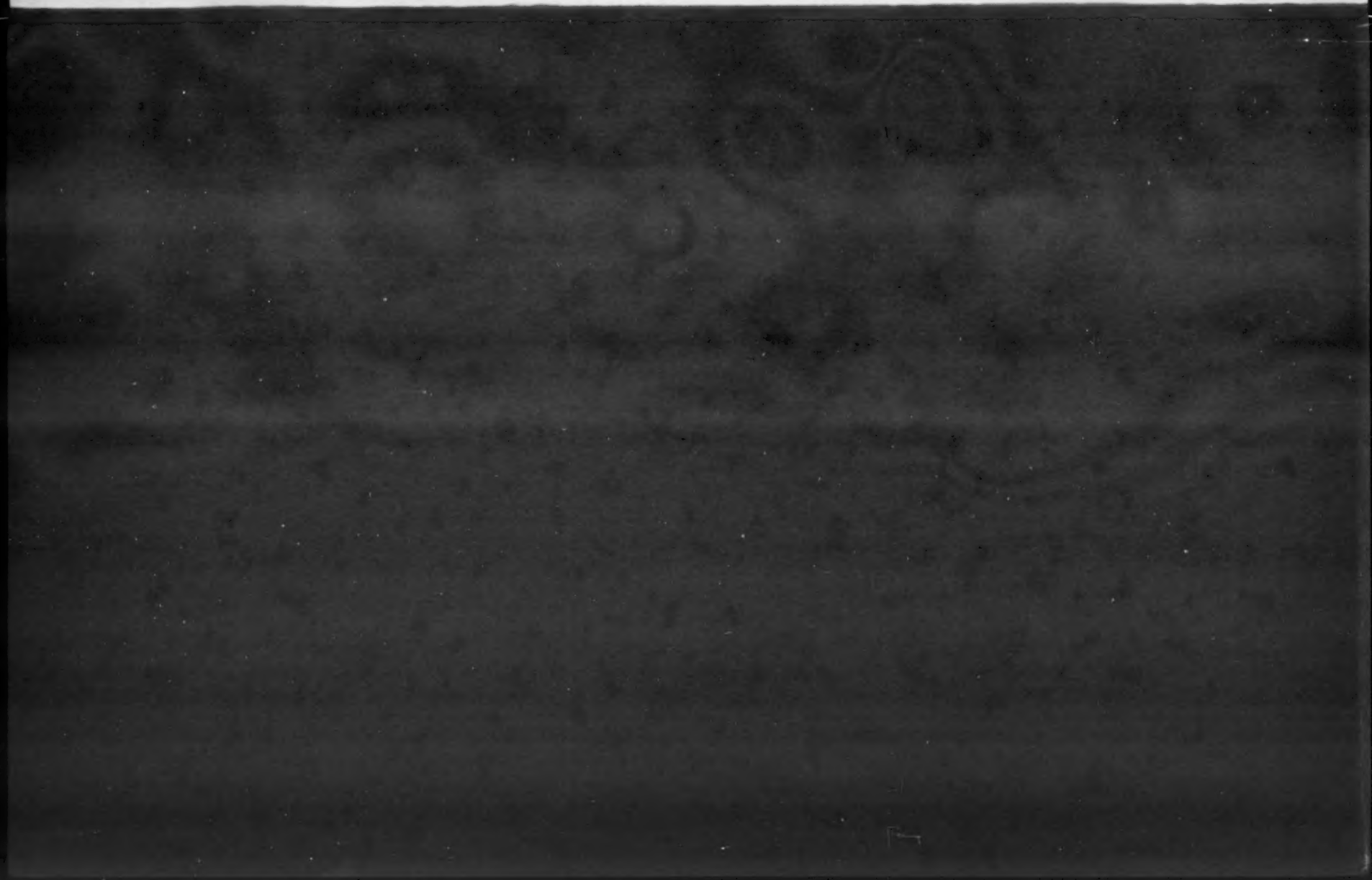

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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1854 - 1934

The Long Struggle Against Cable Crosstalk

IN the year 1935 the Bell System observes the twenty-fifth birthday of loaded quadded toll cable. The anniversary will recall to many of the older telephone engineers a quarter century of struggle against the greatest bugbear of such cable: crosstalk. The tendency for one circuit to repeat its message in an adjacent circuit increases rapidly as the circuits are placed closer together. Since cable circuits are intimately associated both in the cable proper and in the loading coils, the problem of establishing such an electrical balance that crosstalk will not occur is a severe one.

In quadded cable it is especially severe. Each quad is a unit composed of two pairs of wires. Two "side" circuits are operated in each quad, one over each pair. A "phantom" circuit is also operated in each quad, using one pair as the outgoing and the other as the returning path. Between these three circuits crosstalk is particularly difficult to control because the phantom circuit uses the wires of the side circuits and because the two pairs of wires are so close to each other.

History reveals that as early as 1898, three quads were included for experimental purposes in a non-loaded cable which was installed between the John and Franklin central offices in New York City. The crosstalk between the phantoms of these quads and the side circuits was found to be severe. The next experimental attempt to use quads was in 1903, but again unsatisfactory crosstalk results were obtained. Undismayed by these failures, the development engineers resumed the investigation about 1908, when the use of phantom circuits began to look very attractive. While consideration was given to the "spiral-four" type of quad at this time, the multiple-twin type

was chosen as the most promising and it has continued as standard for toll cables in the Bell System.

The multiple-twin quad is formed by twisting together two twisted pairs. This means for reducing crosstalk is similar in principle to the means used on open-wire lines. There the two wires of a pair are "transposed" at regular intervals. By thus interchanging the positions of the two wires relative to those of neighboring lines, the crosstalk currents due to a length of line between two transpositions are made to oppose those from the next length. In the cable, each twist of the wires is analogous to a transposition.

By 1910, a practical multiple-twin quadded cable had been developed, and a loaded cable of this type was installed between Boston and Neponset, a distance of about six miles. While the manufacturing processes used in making this early cable were a vast improvement over the previous processes, the cable as it left the factory was not sufficiently well balanced for commercial operation. Crosstalk between circuits in different quads was minimized by splicing successive lengths of cable in such manner that two quads were adjacent for only a small part of their total length, as is still done today. To reduce crosstalk between circuits in the same quad, "capacitance unbalance test splicing" was devised, and applied in the installation of the cable. By this expedient, crosstalk in one cable length is made to counteract partially the crosstalk in an adjacent cable length. Since 1910, skill in manufacture has further greatly reduced the unbalances in cables, but not enough to do away with capacitance unbalance test splicing in the field, since increases in the length of cable circuits and the advent of telephone repeaters have made it necessary to lower the limits of tolerable crosstalk per unit length of cable.

The general plan of capacitance unbalance test splicing, which was used in 1911 in the original quadded cable installed on the Boston-Washington route, was continued until about 1919. As is still the practice, loading coils were connected in each cir-

cuit at regular intervals of about a mile in order to reduce the attenuation of the telephone currents and prevent the conversations from becoming too faint. Seven capacitance unbalance tests were made in each "loading section," or interval between coils. To make these tests, each loading section was divided into eight approximately equal lengths, as indicated in Fig. 1,

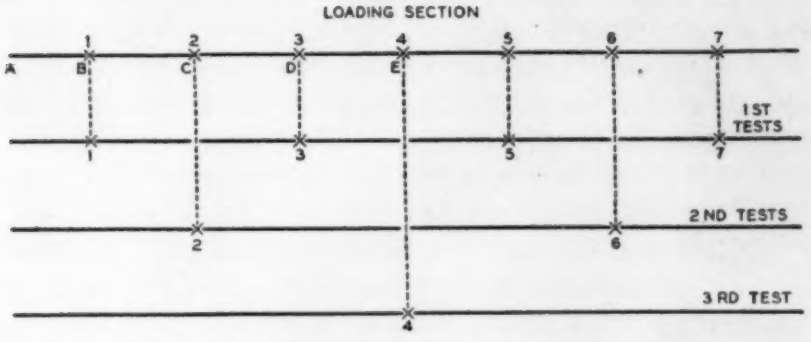


FIG. 1. CAPACITANCE UNBALANCE TEST SPLICES IN A 7-TEST LOADING SECTION.

and splices required within these lengths were made first. Capacitance unbalance tests were then performed at points 1, 3, 5 and 7, with all circuits open at the loading points and at splices 2, 4 and 6. Test 1 was made in such a way as to minimize the unbalanced capacitance in length *AC* of Fig. 1. This was done by splicing together the quads at *B* so as to tend to "neutralize" an unbalance in length *AB* by an opposing unbalance in length *BC*. Tests 3, 5 and 7 were handled in a similar manner. It was also necessary to coördinate Test 1 with Test 3 in order that unbalances of approximately equal magnitude and of opposing relationship would result in the sections *AC* and *CE* which were to be spliced together at splice 2. Similarly, Tests 5 and 7 were coördinated. Tests 2 and 6 were made coördinately upon completion of splices 1, 3, 5 and 7, and finally tests were made at splice 4.

This procedure in greatly modified form survives in present practice. Certain other measures, which were found necessary

during installation of portions of the original Boston-Washington quadded cable, have since been discontinued as the manufacture of cable and of loading coils was improved.

Due to manufacturing difficulties, the first twenty miles of cable manufactured for the Philadelphia-Washington section had unbalances higher than were expected from experience with the Boston-Neponset cable. It was decided, therefore, to place this 20-mile length in the middle of the cable, between Wilmington and Baltimore. In this way, the crosstalk of the 20-mile section became relatively unimportant because of the large transmission loss of the speech in going from either terminal out to the 20-mile section and of the crosstalk in returning to the originating terminal.

Allocation of the loading coils, similar to that of the cable, was also resorted to on the Philadelphia-Washington cable. Furthermore, capacitance unbalance measurements were made on the stub cables of the loading coils in the section from Havre de Grace to Washington. The loading coils were then connected to the section of cable in such manner that the unbalances in the main cable tended to neutralize the stub-cable unbalances. The high stub-cable unbalances on this project were due to the use of textile-insulated stub cables. Changing to a paper-insulated type caused so large an improvement in the unbalances that matching of coil stubs against cable could be discontinued.

The World War greatly increased the demand for additional toll circuits, particularly along the eastern seaboard, and relief cables were required in certain sections. Most materials were scarce at that time, and core materials for loading coils were no exception. Since the core material required for a side-circuit coil at that time was roughly half that required for a phantom coil, it was decided to load only the side circuits in such relief cables, and not to use the phantom circuits. In this way, an amount of core material which previously served three circuits could be made to serve four.

When core materials became more readily available, loading coils were installed on these cables for the phantom circuits also. Normally the three coils required for the phantom and side circuits of each quad in a cable are potted together in the factory, to form a "phantom loading unit." Before the sealing compound is flowed into the pot, suitable measures are taken to minimize the crosstalk caused by all these coils in the three circuits. In the case of the relief cables, whose side circuit coils were already potted separately, crosstalk between the phantom and side circuits had to be reduced by measures taken during installation. The procedure of crosstalk "poling" was adopted. This was somewhat like the method which would have been used in the factory, if these phantom and side circuit coils had been potted together. At each loading point the magnitudes of the crosstalk within each quad were measured for all the pairs of side circuit coils and all of the phantom circuit coils. These measurements formed a basis for selecting the phantom circuit coil to be used with each pair of side circuit coils. The crosstalk within each phantom loading unit was then measured with the phantom coil connected to the pair of side coils in each of the eight possible ways that two quads can be connected together. The eight different ways of connection were readily obtained by the use of a "transposition switch" inserted between the phantom coil and the side circuit coils. Each group of coils was finally spliced in accordance with the transposition giving the minimum resultant crosstalk.

As cable design and manufacturing processes were improved, the capacitance unbalances per reel length of cable were gradually reduced. By about 1919, it was found permissible to standardize a three-test plan of capacitance unbalance testing in place of the seven-test plan: in other words, tests at splices 1, 3, 5 and 7 of Fig. 1 were discontinued. This effected a considerable reduction in the cost of field testing.

The original toll cable circuits were operated without repeaters and the attenuation or weakening of the conversations

was offset as far as practicable by using large wires (No. 10 and No. 13 gauge) and large loading coils. The overall attenuation in these circuits was large, however, as compared with modern standards, and the conversations were relatively faint. The development of amplifying repeaters made it practicable to reduce the overall attenuation greatly, and at the same time to reduce the wire sizes to 16-gauge and 19-gauge, but the reduced attenuation made the crosstalk problem more difficult, for the unwanted crosstalk currents were amplified along with the currents carrying the wanted conversation. Nevertheless, the system of three test splices per loading section, together with crosstalk corrective work performed on the loading coils in the factory, gave satisfactory results until 1922.

At about that time small-gauge toll cables began to receive "extra-light" loading, involving considerably smaller coils than formerly used. This made it possible to extend toll cable circuits to much greater distances without distorting the speech sounds, and to further reduce the over-all attenuation. The longer lengths and lower attenuations increased the difficulty with crosstalk. Furthermore, the nature of these extra-light loaded circuits introduced the very difficult problem of even further improving the loading coils against crosstalk. Without such improvement it appeared that crosstalk in the loading coils would contribute the major part of the total crosstalk in the projected long circuits, and development work was directed towards reducing the crosstalk from this source. While development work on the loading coils was under way a return to the seven-test capacitance unbalance plan was considered as a temporary expedient for reducing crosstalk in the field. Manufacturing improvements, however, had produced cable whose unbalances were comparatively small, and the seven-test plan could not be economically justified by the slight crosstalk reduction which might have been obtained. It was decided to use a system of crosstalk poling for one or more sections of cable and associated loading coils. In general, this method was

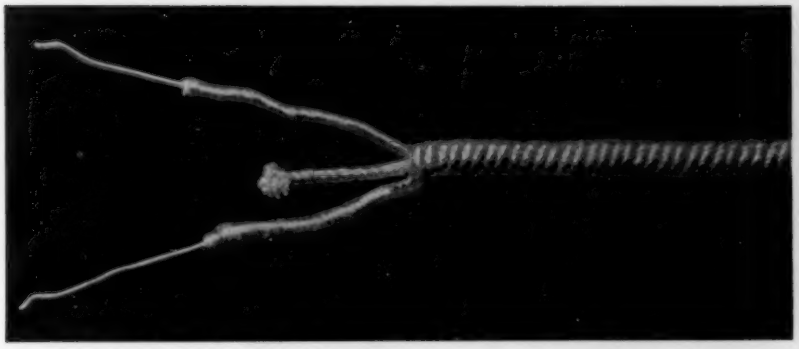


FIG. 2. BALANCING CONDENSER UNIT CONSISTING OF A PAIR OF WIRES WOUND HELICALLY AROUND A TEXTILE CORD.

FIG. 3. BALANCING CONDENSER CONSISTING OF A PAIR OF WIRES WOUND ON AN ISOLANTITE SPOOL.

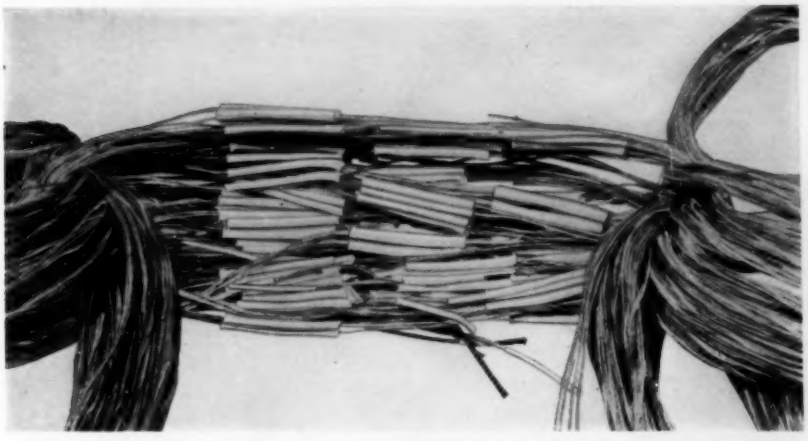


FIG. 4. A SPLICE IN WHICH BALANCING UNITS ARE BEING INSTALLED. FOR ILLUSTRATIVE PURPOSES, THE PHOTOGRAPH WAS MADE BEFORE THE UNITS HAD BEEN COMPLETELY COVERED WITH COTTON SLEEVES.

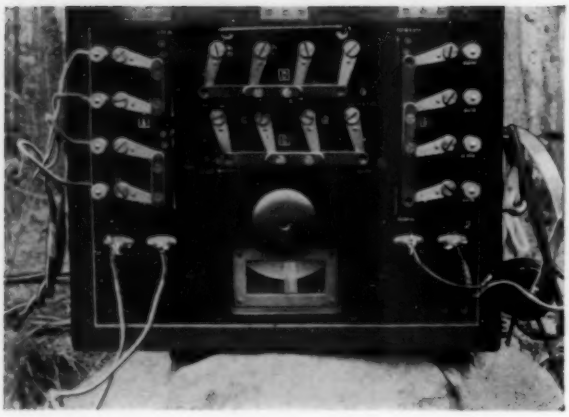


FIG. 5. A 1910 MODEL TESTING SET USED IN CAPACITANCE UNBALANCE TEST SPLICING.

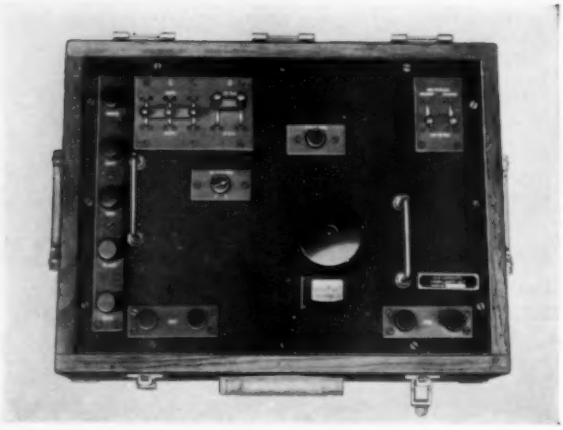


FIG. 6. THE PRESENT MODEL OF TESTING SET USED IN CAPACITANCE UNBALANCE TEST SPLICING.

FIG. 7. SPLICING IN PROGRESS AT CAPACITANCE UNBALANCE TEST SPLICE ON A BURIED CABLE.

FIG. 8. (RIGHT.) A TEST SPLICE ABOVE THE JUNIATA RIVER. THE SPLICE IS BEING MADE IN THE TENT AT THE LEFT; THE TESTER WITH HIS APPARATUS IS ON THE PLATFORM AT THE RIGHT.

FIG. 9. (BELOW.) A TESTER WORKING OUT SPLICING INSTRUCTIONS ON A MILD WINTER DAY. CAPACITANCE UNBALANCE TESTING IS PERFORMED IN ALL WINDS AND WEATHERS.

FIG. 10. A LOADING POINT ON TOLL CABLE. THE LOADING COILS CONTAINED IN THE TWO MIDDLE CASES HAVE BEEN CONNECTED INTO THE CABLE. THE PROCESS OF RAISING CASES TO THE LOADING FIXTURE IS ALSO SHOWN. THE RECTANGULAR CASES ARE MODERN PRESSED STEEL CASES; THE CYLINDRICAL CASE IS OF THE OLDER CAST-IRON TYPE.

FIG. 11. CROSS-TALK POLING TEST ON UNDERGROUND CABLE. IN THE RIGHT FOREGROUND IS THE POLING SET WITH TRANSPOSITION SWITCH, ETC.

similar to that which had been used to reduce crosstalk in loading coils on the relief cables. The number of poling tests required was gradually reduced, as progress was made in the difficult task of meeting the extremely severe requirements for balance of loading coils, and poling was entirely discontinued in 1927.

During all this period it had remained necessary to continue making three test splices within each loading section to reduce the crosstalk occurring within the cable, apart from that occasioned by the coils. In 1929 it became evident that it would be economical to spend less time on the test splicing, and supplement it by connecting small balancing condensers between the wires of some of the quads at some of the splices.

The two wires of each pair of a quad have capacitances to any other conductor in the cable. If the quad were perfectly formed, these two capacitances would be equal. In an actual quad these pairs of capacitances are not quite equal, due to inevitable irregularities in the size, insulation, spacing and twisting of the wires. These capacitance inequalities cause the capacitance unbalances which, if not neutralized, would cause most of the crosstalk between the circuits of a loaded quad. A capacitance unbalance can always be represented by a single capacitance, of one value or another, between a wire of one side-circuit and a wire of the other. The two side circuits could be balanced by connecting a condenser, with the same capacitance as that representing the unbalance, between the *same* wire of one side circuit and the *other* wire of the other side circuit. But, in general, such a procedure would not balance the two side circuits to the phantom circuit. All three circuits can be balanced, however, by connecting not one but three condensers of appropriate values between appropriate wires of the quad.

A remarkably simple balancing condenser has been designed, which is inexpensive, occupies only a small space in the splice, and can readily be adjusted in the field to give the desired

small capacitance. This unit, shown in Fig. 2, is made by wrapping two parallel insulated 22-gauge wires helically around a textile cord. Designed to have a balancing capacitance of about five micro-microfarads per inch, the unit can easily be cut by the installer to the length which will give the desired balancing action. Its capacitance to other wires and the cable sheath tends to be small, and is made negligible by covering each installed unit with a cotton sleeve in order to separate it from other conductors. Under these conditions it is very simple to determine, from a measurement of the three unbalances between the circuits of a quad, a set of three balancing capacitances which will reduce the three unbalances to zero. Three balancing units may then be cut to the right lengths and connected between the proper wires of the quad.

The circuits in quadded cable are operated in two different ways, depending upon the circuit length. In "two-wire" operation, which is used for the shorter circuits, transmission takes place in both directions over each circuit; in "four-wire" operation, used with the longer circuits, each circuit is used for transmission in only one direction. At present two different procedures are used for balancing the crosstalk in cable, according to the relative proportion of the circuits which are operated in these different ways.

Most of the toll cables installed in recent years have had only a small proportion of the circuits operated on a "two-wire" basis. For such cables only one test splice per loading section need be made. At this splice, any excessive unbalances on the two-wire quads, which remain after test splicing, are corrected by means of the little balancing units. The test splicing on the four-wire quads is confined to the reduction of phantom-to-side unbalances alone. After the loading coils have been installed, crosstalk measurements are made on the four-wire quads over the complete repeater section. If the crosstalk is still excessive on some of the quads, it is brought within

satisfactory bounds by the installation of balancing condensers at one end of the repeater section.

Since the terminal balancing capacitances required may be fairly large, it is not practicable to obtain them by using units such as shown in Fig. 2 because the required length makes installation difficult. For this purpose the balancing condensers shown in Fig 3 have been standardized. On a small Isolantite spool (about 1¾ inches long) are wound two parallel 30-gauge cotton-covered wires, and the whole is impregnated in paraffin to exclude moisture. It is adjusted to the required capacitance in the field by unwinding and removing a portion of the wire from the outer part of the spool. As in the units of Fig. 2, the external capacitances are kept small by covering each condenser with a cotton sleeve.

In dealing with crosstalk it is important to distinguish two types; far-end and near-end. If a listener at New York on one circuit heard crosstalk resulting from a talker at Chicago on another circuit, he would be hearing the crosstalk over a far-end path. If the New York listener heard crosstalk resulting from someone at New York who was talking to Chicago on the other circuit, he would be hearing the cross talk over a near-end path. Near-end crosstalk between four-wire circuits is kept satisfactorily low by placing all circuits transmitting in one direction in one portion of the cable, such as the center, and all those transmitting in the opposite direction in another portion, such as the outer layers. It is to reduce far-end crosstalk that the balancing condensers are installed at the ends of repeater sections.

For cables in which a large proportion of the circuits are of the two-wire type, a single test-splice per loading section has been found impracticable because too many balancing units would be required at the splice. Furthermore, the nature of two-wire circuits makes crosstalk balancing at the offices impracticable. The three-test plan of splicing must be continued, therefore, although balancing units might be used as an alterna-

tive to coördinating the tests at splices 2 and 6. Without coordination only a small percentage of quads would have excessive unbalances at the final test splice and these could be corrected there with the balancing unit.

Twenty-five years of improvement in cable, loading coils, and methods of balancing have made it possible to reduce the unbalance testing in the field far below that required on the first Philadelphia-Washington cable. Methods have been found whereby additional work at the factory or at the repeater stations can be substituted for much of the outdoor testing previously required. Probably these developments can be appreciated best by those men who, like the writer, have performed capacitance unbalance tests in all winds and weathers; when the temperature was below zero, and when it was above 100 degrees. Everyone should appreciate, however, that crosstalk conditions today between telephone circuits in modern cables are very much better than those prevailing a quarter century ago and that developments in crosstalk reduction are keeping in step with the ever increasing length of toll cable circuits.

M. A. WEAVER

The Last Word in Telephotography

UNDERLYING all the electrical arts of communication—and these include not only telegraphy and telephony but also telephotography, television and sound pictures—are a few basic principles. To appreciate those fundamentals is to possess a pass key which opens to ready understanding systems of communication which at first thought appear to have no essential in common. Whether the transmission medium is wire or wireless, whether the signals which convey the information are audible or visual, there is a unity to all the communication arts. However different their devices and contrivances may seem to be, all of them are merely means for performing one or another of six typical operations. Four of these operations are essential to any system of communication and the other two to all except the simplest systems.

The four necessary functions of the parts in any system for communication are most obvious. First, if intelligence is to be conveyed from one place to another there must be a generation of some effect which can be transmitted. Then, this something which can be transmitted must be varied so as to embody in its variations the intelligence which is to be transferred. The current, in other words, which has been generated must be modulated in accordance with the signal, or speech, which is to be transmitted. The next function is transmission; and the final one, the detection of the intelligence—an operation the inverse of modulation which is, therefore, called demodulation.

If at any point along the route of transmission the effect would be too feeble for easy recognition it must be amplified. The operation of amplification, although not involved in the simplest of systems, is of importance in most practical systems.

Similarly of practical importance is the sixth and last of the

functional operations, that of selection. Whenever the medium through which transmission is to occur carries simultaneously more than one stream of intelligence, then selection is necessary at the receiving terminal. In radio, since all communication is through a common medium, and in wire whenever multi-channel transmission is desired, each stream of intelligence is carried by a distinctive current. Each stream arises from an individual generator the output of which is modulated by the particular signal or speech it is to carry. The separate streams can be selected one from the other by virtue of the distinctive characteristics of their respective "carrier" currents.

Generation, modulation, transmission, selection, demodulation, and amplification—these describe all the operations essential to any electrical system for the communication of intelligence. When analyzed for these functions, the simple circuit of an electric bell, with its battery and push button, and a very complex system like that for the simultaneous transmission over a single pair of wires of a score of telegraph messages and three or more telephonic conversations, display common qualities. It makes no difference, so far as concerns the types of operation which are required, whether the signal is audible or visual, whether it is conversation or image which is to be transmitted. An illustration of this fact is to be found in the system for the transmission of pictures which Bell Telephone Laboratories has recently developed.

Before that very interesting and ingenious system is described, the unity of principle which runs through the communication arts may well be traced through telegraphy and telephony, both by wire and by radio.

In the telegraph circuit of Morse a battery was the generator of a direct, that is, zero-frequency, current which was modulated at a low rate by the hand operation of a telegraph key. An electromagnet, as a sounder, detected the variations which the key introduced in the current. In the telephone circuit of

Bell a similar zero-frequency current was modulated, but at the higher rate which corresponded to the pitches of the sound waves of air which were impressed upon the diaphragm of the transmitter. At the receiving end of the telephone circuit the electromagnet, instead of reproducing the motion of a key, reproduced by its diaphragm the vibrations of the transmitter diaphragm and thus established waves in the adjacent air similar to those at the sending station. Both inventors, it is to be noted, employed a zero-frequency current, one to modulate it with a frequency of a few cycles a second, or even less, and the other with a band of frequencies corresponding to the tones of the voice.

Communication systems, however, are not limited to the use of zero-frequency currents. A method for producing high-frequency currents was developed by Hertz and employed by him in his discovery of electromagnetic waves. He also developed a method for the detection of such waves. Their utilization in radio telegraphy followed the inventions of Marconi. Equipment is arranged so that a high-frequency current is produced under the control of a telegraph key; the current, in other words, undergoes modulation at the low frequency of hand operation. When the modulated current flows in an antenna, electromagnetic disturbances occur in the surrounding space and radiate to distant antennas, where they establish similar currents.

Almost immediately the possibility of radio telephony became apparent, but it was not to be successfully accomplished over considerable distances until 1915, at which time Bell telephone engineers demonstrated the system they had developed by radio telephone transmission from Washington, D. C., to Paris. An essential in that system was the operation of amplification. A small current of high frequency was generated; this was modulated at audible frequencies by the current from an ordinary telephone transmitter; and the result of that modulation, amplified to the proper power, was then

fed to the transmitting antenna. For transmission through space, high-frequency currents were required; for guided transmission over wires, low or even zero-frequency currents sufficed. Either type of current could be modulated at either the low frequency of telegraphy or at the higher frequency corresponding to audible tone.

When transmission was unguided, as in radio, selection was necessary at the receiving terminal in order to pick out from the multi-channel ether the radiation from a particular station. The criterion of selection was the frequency (or, from another point of view, the wave length) of the high-frequency disturbance which carried in its modulation the intelligence which was being transmitted.

All these functional operations, from generation to selection, are involved in the latest picture-transmitting equipment designed by Bell Telephone Laboratories. In the transmitting equipment, a narrow beam of light falls on the picture which is to be sent, and the latter moves continuously so that the beam scans successively all the tiny areas which compose it. From the picture the beam is reflected into a photoelectric cell. The reflected light varies in amount from instant to instant, according to the relative light or shade of the elemental areas of the picture upon which the beam falls.

In this part of the system one meets again the essential operation of generation, in this case, the production of a light; of modulation, in this case, at the relatively low frequency at which successive areas are scanned; of transmission, across only a few millimeters of space, it is true; and then, in the photoelectric cell, demodulation, or translation, whereby there is produced in the cell a current with variations of intensity identical with those of the reflected beam. The cell detects the light variations and gives rise to corresponding current variations. What it receives as light it translates into a current which can proceed along wires.

Before the current so proceeds, however, amplification is introduced. This is necessary because the current variations produced by the photoelectric cell are so small that they could easily be obscured by any interfering currents which the circuit might pick up inductively. Before the message-bearing currents of the cell start on their long journey they are made superior, by amplification, to the contaminating influences of neighboring circuits.

The amplified current then proceeds along the line to the distant terminal. In the receiving apparatus at that point one meets again the familiar elements of a communication system. There is, first, a generator for a beam of light. This beam, after transmission through a few millimeters of space, falls as a tiny spot of light upon an unexposed photographic film. Before it reaches the film, however, it is modulated, or varied, so as to involve in its varying intensity the intelligence which is to be conveyed. This modulation is accomplished by the current from the distant sending apparatus. A delicate shutter, electro-magnetically controlled by the current, and intervening between light source and film, varies the light in accordance with the variations of current. What reaches the film, therefore, is a beam of light modulated to correspond to the light and shade in successive areas in the original picture. The process of demodulation is accomplished chemically in the film emulsion. There the actinic action, at each instant, corresponds in amount to the light intensity of the beam. In effect, the intelligence, which is embodied in a varied light beam, is translated into a chemical medium. The final detection of the intelligence awaits the chemical development of the film.

The film, which is being exposed at the receiving station, and the picture, which is being scanned at the transmitting station, must, of course, be moved in precise synchronism. How that is accomplished is not a necessary part of the present story. It is obvious, however, that—although it may require considerable ingenuity to accomplish it—all that is required is that

the motors which drive respectively the picture and the film shall run at identical speeds and start at the same instant.

Of particular interest in this method for transmitting pictures is the number of times translations of intelligence occur; that is, the number of media through which transmission takes place. The original intelligence resides in the pattern of light-reflecting powers which the picture displays. Transmission in the first instant is by light waves and these are modulated in accordance with this pattern. The demodulation which then occurs is not one which makes the pattern immediately intelligible to a human eye but is a translation from the medium of light to that of an electric current. Transmission is next by wire, at the end of which a new modulation is accomplished, translating the intelligence from current to light. The final step of demodulation involves the translation of the light variations into corresponding chemical variations of the surface of the film. The pattern of light-reflecting, or light-transmitting, powers thus established on the film is intelligible to the human eye in the same way, and produces the same effect, as the original picture.

Such, in simple terms, is a description of the newly developed system for transmitting pictures; but that description has passed lightly over a further and more interesting illustration of the general principles which this article would emphasize. In the previous description, nothing was said about the character of the light beam which is generated for scanning the picture. By implication it was a steady beam of light; actually such is not the case. What sort of a beam it is, and why, will now be explained.

The picture, which must not be larger than 11 x 17 inches, is mounted on a drum 12 inches in circumference and 17 inches long. It is driven by a screw with twenty-five threads to the inch through a four-to-one gear, so that the drum turns a hundred times while progressing one inch axially. It moves this inch in one minute. Seventeen minutes are thus required

for scanning the maximum size of picture. A beam of light from a stationary source falls upon the picture in a spot about one-hundredth of an inch square, and scans it in a series of adjacent lines one-hundredth of an inch wide. The smallest area, as to the light and shade of which the photoelectric cell can report to the distant receiving station, is one-ten thousandth square inch.

Imagine in any picture—what might be true—that successive areas of this size, which the beam scans, are alternately light and dark. Then the reflected light will pass through alternate maxima and minima, with one cycle for each two adjacent elementary areas; and similarly will the current in the photoelectric cell. This is the most rapid variation which is possible; and its frequency is half the number of elemental areas which the beam scans in one second. Because the beam scans twelve square inches each minute, each containing 10,000 elemental areas, it covers 120,000 of them in a minute, or 2000 in a second. Hence, the highest possible frequency for the current is one thousand cycles per second.

That is the maximum frequency. The minimum frequency which would exist when the picture was uniform in tone can be computed as follows: The largest picture can occupy eleven-twelfths of the drum, the remainder is allowed for clamps to hold the picture. The light beam scans a line eleven inches long before it falls on the clamps. For 11/20 second it scans the picture and for the next 1/20 second it falls on the clamps. In 12/20 of a second, therefore, the reflected beam would pass through a cycle of maximum and minimum intensity. That means a frequency of a little less than two cycles per second.

The ordinary picture involves all conditions between these two extremes, and so may introduce modulation at any frequency from almost zero to 1000 cycles per second. It is difficult, however, to transmit all frequencies of that band with the same efficiency; but it must be done if the light and shade

of the picture are to be faithfully reproduced at the receiving station.

Now it happens that the frequencies which a telephone line ordinarily transmits, without undue discrimination, lie in a range from about 200 to 2800. That meets the requirements of intelligibility and naturalness. If the thousand cycle band required by a picture extended not from zero to 1000 but from 1400–2400 its transmission could be easily and adequately accomplished by a properly equipped telephone circuit. The designers, therefore, arranged that the band of frequencies, which represents the variations in light and shade of the picture, should be transmitted as a band extending from 1400–2400.

In earlier telephoto equipment, which the Bell System put into service about 1925, this was accomplished by the method of carrier-current operation, using a high frequency for the carrier and modulating it with the current from the photo-electric cell. As will be recognized from the previous discussion, this is similar to the method of radio telephony where a high-frequency current is modulated by the audio-frequency current from a transmitter. Instead, however, of doing it this way, the designers of this particular apparatus arranged that the high frequency effect which was to be modulated should be introduced in the optical part of the transmitting system, that is, into the light which falls upon the picture.

Before the light reaches the picture it passes through an electromagnetically-controlled shutter. The shutter, or light valve, as it is called, is formed by a fine wire in a magnetic field. When current flows, the wire moves sidewise, cutting off more or less of the light from the lamp. Current of 2400 cycles per second is supplied to the wire from an oscillator of the vacuum-tube type. The valve, therefore, oscillates at the same frequency and produces corresponding variations in the intensity of the light which passes through it. When this

beam falls upon the picture it is modulated in conformity with the light and shade of successive elementary areas.

The current from the photoelectric cell follows exactly the variations in intensity of the light beam. The current, therefore, is an alternating one of 2400 cycles per second, and its strength undergoes variations at the lower rate at which the details of the picture are scanned. There is, however, another way of considering this current—and there is simple trigonometry in substantiation of it. It may be resolved into, and hence considered to be composed of, three components. One of these is a current of steady strength and frequency 2400 cycles. The other components are, respectively, higher and lower than that frequency, and vary in strength in accordance with the light and shade of the picture. The frequency of one of these components is above 2400 cycles by a number of cycles corresponding, at any instant, to the frequency introduced by scanning successive areas of the picture. The other component has a frequency correspondingly below 2400 cycles. Since all frequencies which the picture elements can introduce lie between zero and 1000 cycles the "side band" currents, which have just been described, will have frequencies in the ranges 2400–3400 and 1400–2400 respectively.

The intelligence, or signal, which is to be conveyed from the picture is involved in these three components of the modulated carrier current. For its interpretation, however, both side bands are not necessary. One side band and the carrier are sufficient. In the system under description, therefore, only the lower side band is transmitted. This is accomplished by introducing into the circuit, immediately following the photoelectric cell, an electrical filter which allows to pass only currents whose frequencies lie in the band 1200–2600.

The carrier current and its lower side band then proceed to the receiving station. Amplification is introduced as necessary along the route. At the receiving station this current is demodulated, giving rise to a current, of frequency zero to one

thousand cycles, which is proportional at each instant to the light and shade of an element of the distant picture. This current operates a light valve, similar to that which is used at the sending station, which is interposed between a steady lamp and an unexposed film. Through its action the amount of light which falls on the film is varied from instant to instant in accordance with the light and shade of a corresponding area of the original picture.

From the standpoint of practical engineering there are many advantages to this recently developed system. It is also interesting because it illustrates so completely, and in such a variety of ways, the fact that all systems of electrical communication are constructed around six fundamental operations of generation, modulation, transmission, demodulation, amplification and selection.

JOHN MILLS

Present-Day Housing in Sixty-four American Cities

HOUSING in the United States is at the present time a subject to which the public press is devoting a great amount of space. Adequate housing for all is a social ideal towards the realization of which both public and private agencies are exerting much effort. In so far as the attainment of the ideal involves slum clearance, some notable steps have already been taken. Moreover, a revival of home building sufficiently great to meet the stored-up demand of the depression years is widely regarded as an essential stimulus to the recovery of industry. In view of the subject's interest and importance, the facts revealed by the preliminary reports of the Real Property Inventory made during 1934 in 64 cities* throughout the country are not only timely but also provide data exceedingly useful in appraising present housing conditions and future possibilities. They also present a picture of contemporary American living conditions of considerable social significance.

The Real Property Inventory in these 64 cities was undertaken early in 1934 as a Civil Works Administration project, conducted by the Bureau of Foreign and Domestic Commerce. It covered all residential properties exclusive of hotels, rooming houses, clubs, and summer cottages; and statistics were collected on a variety of items, including the type, material and condition of all structures, the installed household equipment in dwelling units, rentals and property values, the distribution of families in living quarters, etc. Each of the 48 states was represented in the Inventory by at least one city, and an effort was made to have the cities chosen include typical industrial,

* These cities are listed at the end of this article, on page 40.

commercial, and resort communities and show considerable diversity in point of size. The cities range in population from 11,000 to 900,000, and the 64 communities include 33 where the inquiries were made only within the city limits and 31 so-called metropolitan areas, in which the surrounding suburbs were included. (In addition to this group of cities where the surveys were conducted wholly under the supervision of the Bureau of Foreign and Domestic Commerce, a number of other large cities were studied, partly on the same basis and partly as a local undertaking. New York, Philadelphia, Pittsburgh, Detroit, Chicago, Buffalo and the New Jersey cities in New York's metropolitan area are among them, and in some of these cases at least, non-residential properties were included in the Inventory. Only fragmentary results of these surveys are as yet available. A survey made in Cleveland in 1932 served as an experiment from which were developed the methods used in the 1934 studies.)

The particular purpose of the surveys, to obtain information on the condition of urban housing in the United States, makes the results not exactly comparable with other enumerations covering some of the same facts included in the Inventory, as, for example, the 1930 Federal Census of Population, where an accurate count of the population was the first consideration. Moreover, the environs included in the metropolitan areas, though they might perhaps be assumed to correspond with the "Metropolitan Districts" of the 1930 Census, are not defined or described in the preliminary reports of the Inventory; consequently any attempts at comparison with the Census must be limited to the 33 cities for which the data are on a geographical basis known to be the same at the two dates.

From the data on these 64 cities, whose limits contained nearly 8,000,000 inhabitants in 1930 and in which some 2,600,000 dwelling quarters have been enumerated, one can get a picture of what may be considered representative conditions in American urban communities. Some of the facts bear out

the popular conception of our living standards, while others indicate rather startling deficiencies in certain directions. If we were to imagine that a typical city could be described by the medians of the many items covered for these 64 communities, we should find it to be a city of about 75,000 population, where more than two-thirds of the dwelling units are in single-family houses, where over 40 per cent of the occupied units have resident owners and where the average home has five rooms. More than one-third of the residential structures have been built since the war, and about 85 per cent of them are made of wood. With respect to the usual equipment, we should find less than 8 per cent without running water, but nearly 20 per cent with no private indoor toilet facilities and more than one-fourth with no bathtub or shower. About six per cent are lighted by some means other than gas or electricity, and nearly 25 per cent are not equipped to cook by either gas or electricity. Over half have no central heating system. Nearly 25 per cent of the dwelling units have had their present occupants more than ten years, while over 30 per cent have had their present tenants less than a year. In each 100 occupied dwellings there are seven families living "doubled up" with the usual occupants, and seven per cent of the total dwelling units are vacant. There are 55 automobiles for each 100 occupied dwellings, and 16 per cent of the total number of living quarters are equipped for mechanical refrigeration. Individual cities of course vary widely from this composite median community, in some respects because of differences due to climatic conditions, in others because of the variation in age, and in still others because of the marked differences in their average standards of living. It is these last variations which are of the greatest interest.

In general, the published facts may be divided into three groups: (1) those dealing with the structures and their condition; (2) those describing the household equipment, mainly that permanently installed; (3) those dealing with general liv-

ing conditions and factors which indicate spending ability and tendencies. Table I shows the median percentages for a number of the items on which information was gathered and also shows the extremes of high and low percentages and the communities in which they occur.

Structures

The tendency towards the erection of apartment house structures in urban communities either because of high land values or because of a desire for smaller living quarters has not yet resulted, in these cities, in a condition where multi-family structures house a majority of the families. The highest percentage of dwelling units in multi-family structures in any of these cities occurs in Waterbury, Conn., where 51.6 per cent of the living quarters are in buildings with three or more dwelling units; but of these units more than half are in three-family houses and less than one-third come within the class called "apartments." In only seven of the 64 cities are more than one-third of the dwelling units located in other than one- or two-family houses; and in only 15 cities, 11 of which are in the Northeast area, do two-family houses contain 25 per cent or more of the total number of living quarters. The median percentage of dwelling units in single houses is 67.5. Outside of our largest metropolitan areas, then, American families in urban communities seem to have remained housed, for the most part, in structures planned for single families.

The data in the Real Property Inventory in regard to the condition of structures are based on the judgment of the enumerators, who classed them as "good," "needing minor repairs," "needing structural repairs," or "unfit for use," according to their conception of local standards. Sixty per cent of all the residential structures in the 64 cities were found to need repairs of some sort, but in only one-fourth of the cases were the needed repairs of a structural nature. The average percentage of structures in good condition is 37.5 per cent, and

of those unfit for human use, 2.3 per cent. The best conditions are reported in the Northeast, where the median percentage for structures in good condition is highest and that for structures unfit or needing major repairs is lowest. On the basis of the average number of dwelling units per structure, there are 60,000 dwelling units in the entire group of cities in structures not adequate for use.

More than three-fourths of all the structures enumerated have been built since 1900, in spite of the fact that a number of the cities included were founded early in the country's history. The proportion of old structures in each city, in general, declines as the distance from the eastern seaboard increases; the proportion of structures built since 1920 increases (to more than 60 per cent in some cases) in those areas, especially in the Southwest, where rapid population growth was taking place in the 1920–1930 decade.

The slump in building activities since 1929 is reflected in the number of structures built per year in the past five years and in the preceding ten years. The 64 cities taken as a group have been building at the rate of 26,000 structures a year from 1929 to 1934, a 60 per cent decline from the annual rate of 65,000 structures in the ten years from 1919 to 1929. The Census of 1930 reported about 2,075,000 families in these 64 cities (exclusive of the families in the environs making up the metropolitan areas) in 1930, and the gain in families from natural increase alone would absorb most of the new living quarters, with no adequate provision made for the gains in the demand for dwelling units due to inward migration from outside areas or for losses in dwelling space due to conversion to other uses, fire, or demolitions.

Home Facilities

The cities in the various sections of the United States differ strikingly in the proportion of their homes equipped with the fundamental facilities making for convenience. Running water

TABLE I

SELECTED DATA ON 64 CITIES
WITH REGARD TO HOUSING AND HOME EQUIPMENT

Items	Median for 64 Cities	Extremes			
		Low City		High City	
		Per Cent	Place	Per Cent	Place
Per Cent of Structures which are Single Family Houses	84.9	54.0	Providence, R. I.	95.0	Springfield, Mo.
Per Cent of Dwelling Units in Single Family Houses	67.5	28.9	Portland, Me.	86.9	Springfield, Mo.
Per Cent of Structures Built of—					
Wood	84.7	1.5	Sante Fe, N. M.	96.8	Providence, R. I.
Brick	8.2	0.4	San Diego, Calif.	61.4	Salt Lake City, Utah
Concrete or Stucco	2.9	0.4	Portland, Me.	35.8	Phoenix, Ariz. Minneapolis, Minn.
Per Cent of Structures—					
In Good Condition	37.1	20.2	Paducah, Ky.	55.4	Binghamton, N. Y.
Needing Minor Repairs	44.4	34.0	Charleston, S. C.	54.2	Jackson, Miss.
Needing Structural Repairs	16.5	6.8	Binghamton, N. Y.	31.4	Paducah, Ky.
Unfit for Use	1.9	0.4	Binghamton, N. Y.	8.0	Paducah, Ky.
Per Cent of Structures Built—					
Since 1920	35.6	6.7	Butte, Mont.	65.8	Oklahoma City, Okla.
Before 1885	5.8	—	Wichita Falls, Tex.	38.6	Charleston, S. C.
Per Cent of Occupied Dwelling Units with Resident Owner	43.2	20.0	Charleston, S. C.	53.3	Racine, Wis.
Per Cent of Occupied Units Having Present Tenants—					
Less than one year	31.3	18.9	Trenton, N. J.	51.5	Phoenix, Ariz.
More than ten years	23.6	11.4	Oklahoma City, Okla.	32.5	Williamsport, Pa.

TABLE I—*Continued*

Items	Median for 64 Cities	Extremes			
		Low City		High City	
		Per Cent	Place	Per Cent	Place
Per Cent of Dwelling Units Vacant	7.0	1.8	Jackson, Miss.	15.9	Butte, Mont.
Per Cent of Vacant Dwelling Units Unoccupied for					
Less than 6 Months	58.6	26.4	Butte, Mont.	76.2	Oklahoma City, Okla.
More than 2 Years	13.0	4.3	Albuquerque, N. M.	40.4	Butte, Mont.
Per Cent of Dwelling Units with Space					
Adequate or Better	83.4	60.4	Charleston, S. C.	91.9	Portland, Ore.
Overcrowded	1.4	0.2	Lansing, Mich.	10.3	Charleston, S. C.
Per Cent of Dwelling Units with—					
Running Water	92.2	70.4	Paducah, Ky.	99.6	Burlington, Vt.
Central Heating	46.4	0.4	Shreveport, La.	86.9	Lansing, Mich.
Lighting by Gas or Electricity	93.9	50.0	Charleston, S. C.	98.8	Butte, Mont.
Cooking by Gas or Electricity	76.7	19.0	Knoxville, Tenn.	94.6	Cleveland, Ohio
Private Indoor Sanitary Facilities	81.1	51.3	Charleston, S. C.	98.3	Burlington, Vt.
Tub or Shower	74.2	43.8	Charleston, S. C.	91.4	San Diego, Calif.
Mechanical Refrigeration	16.0	6.4	Paducah, Ky.	27.6	Lincoln, Neb.
Average Number of Rooms in Dwelling Unit	5.0	3.6	Butte, Mont.	6.3	Trenton, N. J.
"Extra" Families per 100 Occupied Dwellings	7.1	2.5	Casper, Wyo.	13.5	Jacksonville, Fla.
Passenger Automobiles per 100 Occupied Dwellings	55.4	29.0	Charleston, S. C.	72.2	Lincoln, Neb. Sacramento, Calif.
Other Data:					
Population in City Limits in 1930	73,400	11,200	Sante Fe, N. M.	900,400	Cleveland, Ohio
Per Cent Native White	82.0	52.3	Charleston, S. C.	95.4	Springfield, Mo.

and bathroom facilities have come to be regarded as the minimum in household equipment with which any American family, unless it is in a remote area, can be expected to be content. Nevertheless, those facilities are far from universal.

The older cities of the Northeast (east of Ohio and north of the Ohio and Potomac rivers), as might be expected, have the highest percentage of homes reporting running water, bathtubs or shower baths, and private indoor toilets. By no means all homes in this area can boast of all those advantages, but only Wheeling and Wilmington stand out as cities where more than a negligible fraction of the families must do without running water. In Wilmington, eight per cent of the dwelling units are without it, and in Wheeling more than 26 per cent. Tubs or showers are, of course, much less prevalent in dwellings than running water. Among the northeastern cities, Binghamton is best supplied, with all but 9.2 per cent of the dwelling units having tubs or showers; and Wheeling least adequately supplied, with almost half of its dwellings without such facilities. Generally, more homes have private indoor toilet facilities than have bathtubs or showers, but even in this relatively well equipped area about 10 per cent of the dwelling units report no such conveniences.

Away from the northeastern area, the average percentage of dwelling quarters without proper facilities rises considerably. Instead of a median of 2.5 per cent of dwelling units without running water, as in the group of northeastern cities, the median among western cities is 5.8 per cent, in the Middle West 8.0 per cent, and in the South 13.7 per cent, while in one community, Paducah, Ky., the figure reaches 29.6 per cent. The medians of the percentages of homes without their own indoor toilet facilities are 8.7 per cent for northeastern cities, 17.1 per cent for western, 18.6 per cent for middle-western, and 29.8 per cent for those in the South. Tubs or showers are not installed in an average of 17.4 per cent of these northeastern cities' homes, in 18.2 per cent of those in western states,

in 25.2 per cent of those in the middle-western group, and in 35.3 per cent of the southern cities' dwelling quarters.

The proportion of homes with central heating (that is, a furnace providing steam, hot water, or hot air heat) is affected both by economic conditions and by climate. Figures for cities of the South and Southwest range about a median of less than 10 per cent of homes with installed furnaces; among western cities the median is 40 per cent, but temperatures vary so widely for that group that the figure is not especially significant. The percentage of homes so equipped ranges from 7.0 per cent in San Diego to 65.0 per cent in Portland, Ore. More nearly uniform climatic conditions prevail in the Northeast and Middle West, however, and all houses require some provision for heating. Consequently, economic conditions are the more influential, and the contrast between the Middle West, where the average city has 25 per cent of its dwelling units heated otherwise than by furnace, and the Northeast, where 37 per cent must depend on stoves or less efficient means, is striking on that account. The most heavily industrial cities of the Northeast—Providence, Worcester, Waterbury, and Wheeling—all have less than half of their living quarters heated by furnaces.

In three-fourths of the cities, coal is still the dominant fuel used for heating, and in most of the others (mainly in the Southwest) natural gas heats the largest proportion of homes. Fuel oil has been adopted by some families in practically all of the communities, but in only seven cities are as many as 10 per cent of the dwelling units heated by this means. The seven—all remote from coal fields—are Portland, Me., Nashua, N. H., Burlington, Vt., Worcester, Mass., Lincoln, Nebr., Portland, Ore., and Seattle, Wash.

The prevalence of adequate lighting in the cities throughout the country is reflected in the small percentage of homes not lighted by gas or electricity. Medians for the Northeastern and the Western cities included in the Inventory are the same,

3.1 per cent of the dwelling units depending on other means than gas or electricity; the median in the Middle Western group is 4.2 per cent, while in the South it is 27.8 per cent. These figures serve to emphasize what data on other facilities have indicated: the contrast between housing conditions in southern cities, with their large proportion of negro population of low earning power, and in cities in the remainder of the country. On the basis of these 64 cities, the average percentage of southern urban dwellings without gas or electric lights is greater than the highest percentage occurring in any city outside that section.

Cooking by means of gas or electricity is, of course, not so common as lighting. Gas is the most usual fuel, and yet more than one-quarter of the dwelling units in these 64 cities are not equipped for the use of either gas or electricity for cooking. Southern cities again are conspicuous in that a high average of homes use some other fuel; Asheville and Knoxville are especially high, each with less than one-fourth of their dwelling units using gas or electricity. The average proportion of homes using gas or electricity for cooking is slightly higher for places supplied with natural gas than for those not so supplied, but the difference is too small (79.5 per cent as against 73.6 per cent) for the presence of that cheap and efficient fuel to be considered a factor in the popularity of gas for cooking purposes in many communities. The lower cost of coal or wood is probably more influential in limiting the use of gas in the majority of cases.

General Housing Conditions

The Real Property Inventory reveals that of the more than 2,600,000 dwelling units available in the 64 cities at the time of the enumeration, about 1,000,000 were occupied by the owners, 200,000 were vacant, and the remaining 1,400,000 were rented. The number of rooms per dwelling unit and the

number of persons per room indicate that in most of the 64 communities the major part of the population is adequately housed so far as space and opportunity for privacy are concerned.

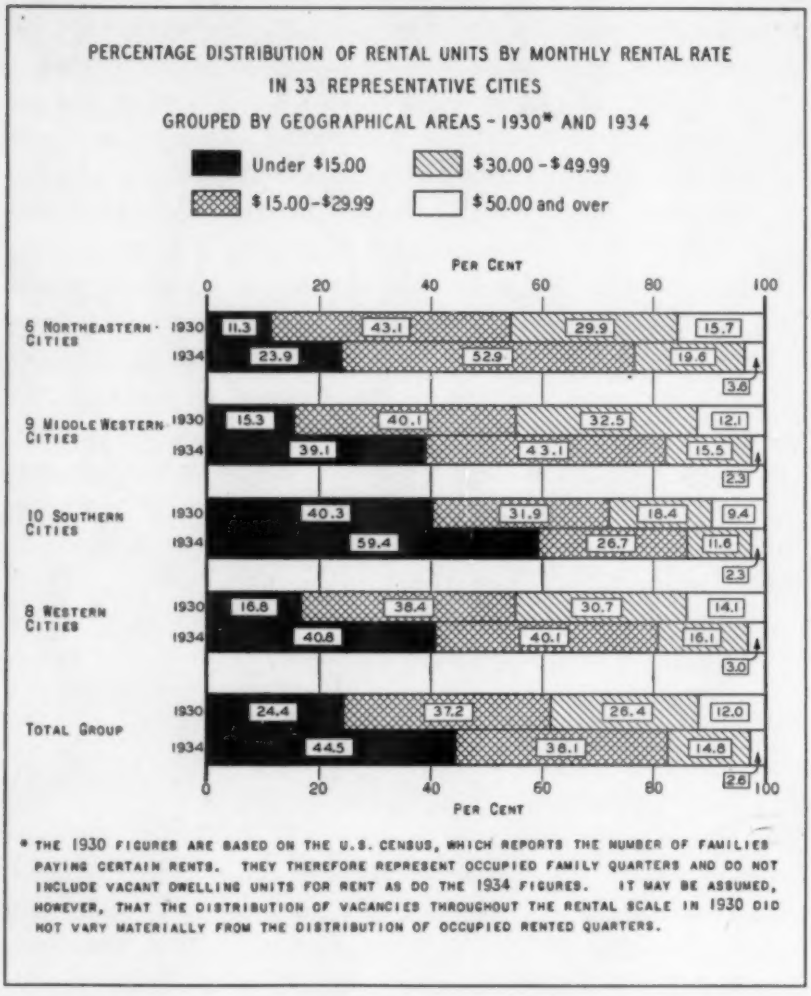
Among the occupied dwelling units, 83 per cent were reported to provide space adequate—or better than adequate—for the number of people living there (one person or less per room is considered to indicate "adequate" living space), 15 per cent were crowded (one to two persons per room), and two per cent were overcrowded. The enumerators' interest was not primarily in population, and it is possible that the proportion of homes reported to be adequate may be somewhat higher than is actually the case, since it might be expected that some of those interviewed would report only the number of family members and omit mention of any roomers or servants also living there. To some extent the adequacy of dwelling quarters varies with the average number of rooms in the homes of these cities. The median of the average number of rooms per dwelling unit for the entire group is 5.0, while that of the cities in the Northeast is 5.9, of those in the Middle West 5.15, of southern cities, 4.6, and of western communities 4.5. Trenton has the highest proportion of large homes, with an average of 6.3 rooms, and Butte the lowest, with an average of 3.6 rooms.

About 30 per cent of all the dwelling units in the 64 cities have had new tenants within a year, nearly another 30 per cent have had the same occupants from one to five years, and over 40 per cent have had no change in occupants for more than five years. In view of the 43 per cent of homes reported owned by the occupants, with a high degree of residential stability, renting families must move much more frequently than is indicated by the above figures.

Rentals

That the income to landlords from rented dwelling units has dropped materially since 1930 is shown by the data for

the 33 cities where enumerations of this item made in 1930 and 1934 are on a similar area basis. The figures themselves are not exactly comparable, since the Census covers only occupied



* THE 1930 FIGURES ARE BASED ON THE U.S. CENSUS, WHICH REPORTS THE NUMBER OF FAMILIES PAYING CERTAIN RENTS. THEY THEREFORE REPRESENT OCCUPIED FAMILY QUARTERS AND DO NOT INCLUDE VACANT DWELLING UNITS FOR RENT AS DO THE 1934 FIGURES. IT MAY BE ASSUMED, HOWEVER, THAT THE DISTRIBUTION OF VACANCIES THROUGHOUT THE RENTAL SCALE IN 1930 DID NOT VARY MATERIALLY FROM THE DISTRIBUTION OF OCCUPIED RENTED QUARTERS.

homes renting at specified levels, whereas the Real Property Inventory includes, in addition, vacant dwelling units for rent. This variation in viewpoint explains in part the difference between the 200,600 rented homes in 1930 and the 247,300 rental

units in 1934 (probably most of the 27,400 vacant dwelling units in 1934 are for rent); no doubt an increase in rental units has also occurred as a result of foreclosures or of an effort on the part of property owners to forestall foreclosure by leasing their homes and renting cheaper quarters for themselves. In spite of this difference in the total figures, however, it is probable that the distribution by rentals at each date is not much affected. The accompanying chart shows the differences in rent levels at the two dates and also brings out the variations in general rent conditions by geographical regions.

Besides these comparisons, the medians at the two dates present some interesting contrasts. In 1930 the median percentage of homes in these 33 cities renting for less than $15 per month was 19.0 per cent; in 1934, 41.8 per cent. Similarly, the median percentage of units renting for less than $30 was 64.3 per cent in 1930 but 82.6 per cent in 1934; while at the upper end of the scale the median of units renting for $50 or more was 11.3 per cent in 1930 but only 4.6 per cent was in that group in 1934. Reports for 40 of the cities surveyed in 1934 show more than half of the rental units available for $20 or less per month; in fact, in 17 cities half of the units might be had for $15 or less, while in two communities more than 50 per cent might be rented for under $10.

Home Ownership

The approximately 1,000,000 dwelling units with resident owners represent less than 43 per cent of the occupied dwelling quarters in this group of cities. More nearly uniform conditions prevail throughout the North and West in home ownership than in many other respects (approximately 45 per cent), but homes occupied by the owners in the South amount to only 34 per cent of the total occupied dwelling units. At the time of the 1930 Census, 42.8 per cent of all urban homes were owned; thus the status of home ownership as a whole in urban

areas does not appear to have been materially affected by the years of depression. In the cities where some comparison with 1930 conditions is possible, 43.8 per cent of the homes were owned at that date and 40.3 per cent had resident owners in 1934. This decline measures to some degree the loss of homes under emergency conditions, but cannot reflect the total shift in home ownership by individuals, which has no doubt been considerable. In every community there have been many families forced to discontinue mortgage payments, with consequent loss, and also many buyers of such properties at bargain prices. The decline of almost 14,800 in the number of homes occupied by their owners, while the total number of occupied dwelling units was declining by only 3,900, is a further indication of the tendency for some owners to rent their homes and move to cheaper rented quarters.

In reply to the question asked property owners as to the value of their homes, the answers were sufficient either in number or in apparent accuracy to justify tabulation in only 38 cities, and even so more than 10 per cent of the owned homes in these cities are tabulated with no value reported. Since the values reported are the owners' appraisals, the figures may be assumed to represent various points of view—what was paid for the property, what the owner would have to be offered to let it go, or what he thinks he could get for it under present market conditions. With these qualifications in mind, it is interesting to note that in the 38 cities (24 of them being "metropolitan areas") two-thirds of the owned homes for which values were reported were valued at less than $5,000 and that $8,000 would be the upper limit of value for all but about 10 per cent of the homes. The largest single group is that of homes with values of from $3,000 to $5,000, which make up 30 per cent of the total number reported.

The downward revision in realty values in the last few years is illustrated by the changes in the distribution of owned homes by valuations from 1930 to 1934 in the 14 cities of the "city

limits" group where comparison is possible. Only 28 per cent of the owned homes reported in that group in 1930 were valued at less than $3,000; in 1934 more than half were so valued. The same group (those valued at from $3,000 to $5,000) was the largest at both dates. At the upper end of the scale, 15 per cent of the owned homes were considered by the owners to be worth more than $10,000 in 1930, but in 1934 only 5 per cent were so appraised.

Vacancies

Vacancies in the living quarters of a city indicate the existing space available for population expansion. A certain amount of vacancy represents a normal condition, where there is just about as much extra room as will accommodate the growth of the community in the immediate future. Vacancies large in proportion to the total dwelling units may be a sign of (1) an overbuilt condition or a large number of antiquated structures, (2) simple preparedness for a rapidly increasing number of families, (3) congestion where a considerable number of families are sharing living quarters with others for reasons of economy or, perhaps, because of a building shortage only recently corrected, or (4) a recent outward movement of population. Commercial surveys made by telephone engineers approximately ten years ago in 14 of these cities showed vacancy ratios ranging about a mid-point of 4.1 per cent. In most cases buildings under construction were included as vacant dwelling quarters, so that it is probable that a normal vacancy ratio at that time was about 3.5 per cent. About twice as many vacancies in proportion to the number of dwelling units were found in these same cities in 1934. In both periods, of course, the vacancies include a number of living quarters which are in too poor a condition ever to be used again.

The vacancy ratio of 7.8 per cent for the entire 64 cities does not indicate an overbuilt condition in many communities. The 204,000 empty dwelling units are counterbalanced by 184,000

"extra" families* (those sharing living quarters with the usual occupants) and 44,000 structures considered, by local standards, to be practically unfit for human habitation, although some were occupied. If these totally inadequate homes were eliminated, the number of potential householders now living with others would exceed the available living quarters by more than 25 per cent. It is probable that some of the "extra" families are now permanently established with the usual occupants, and also that when other families are reestablished, their homes will not necessarily be in the same communities; but even so, the stored-up demand for housing and all its facilities is plainly a large one.

Of the 200,000 dwelling units vacant at the time of the enumeration, only a relatively small proportion had been standing empty for a considerable length of time. Fifteen per cent had had no tenants for more than two years, and another 13 per cent had been vacant for at least a year, but for 56 per cent the period was less than six months. It is noteworthy that the current causes of vacancy—decline in the rate of family growth, "doubling up" of families, or the movement of industrial workers away from cities to small towns or rural areas—seem to have taken effect in the cities of the Northeast earlier than in the other sections of the country. Outside that area the median percentages of vacant dwelling units unoccupied for less than six months are all approximately 60 per cent, while in the Northeast it is about 50 per cent; correspondingly, the median percentage of unoccupied units in that area vacant more than two years is about 19 per cent, whereas elsewhere it is about 12 per cent.

* The enumeration of "extra" families is a new and useful piece of information. The U. S. Census counts as one family all related individuals living under the same roof and sharing the same table, and any indication of "doubling up" can be obtained only by indirection from the movement of the ratio of persons to families.

Other Features

The Real Property Inventory covers various other points, some of which are particularly interesting from the standpoint of market opportunities in these communities. They show that there are more than half as many passenger automobiles in these 64 cities as there are occupied dwelling quarters and that 55 per cent of all structures have garages, with an average capacity of 1.6 cars. In the West and Middle West, the number of passenger cars per 100 occupied dwellings is especially high, 62.8 being the median among western cities and 59.5 for middle western communities. In the cities of the South and Northeast, however, the number of cars is less than half the number of occupied dwelling units (47.5 and 46.8 are the respective medians). For every 100 occupied dwelling units in the 33 places with a comparable area in 1934 and 1930, there are 54 passenger automobiles, as compared with 48 residence telephones on January 1, 1934 and 37 families with radios in 1930.

In view of the spread between the low and the high of the sectional medians in the ownership of automobiles, it is interesting to note that about the same degree of progress has been made in providing mechanical refrigeration in cities in all parts of the country. The median among western cities is the highest, at 17.5 per cent of all dwelling units, and lowest in the South, at 14.1 per cent.

The number of homes owned clear of mortgages is a factor in judging the quality of markets. Nearly half of the owned homes in the 14 smaller cities and more than a third in the 24 metropolitan areas for which the information is available have no mortgages. These are minimum percentages, since for about 14 per cent of the owned homes the terms of tenure are not reported.

Conclusion

This discussion of housing and its facilities has served to bring out the facts that urban housing conditions vary widely in different parts of the country, that in every city—at least so far as these 64 communities are typical—there are numerous families (in some places a considerable portion of the population) inadequately provided with ordinary conveniences, and that there is a large unsatisfied demand for housing, represented by the excess of families living with other families over the number of vacant dwelling units suitable for use.

There should perhaps be added a note of caution as to the use of figures for specific communities. In view of the conditions under which the Real Property Inventory was taken in most cities, with a hastily trained group of workers making the survey in a limited time, it would be unreasonable to expect complete reliability. Some internal evidence was found that the enumeration was not accurate in every detail, and it is probable that when the final reports are issued they will contain some changes from these preliminary tabulations.

Dorothy Bolles

The following cities (metropolitan areas starred) were included in the Inventory:

Northeast	*Middle West*	*South*	*West*
Portland, Me.	*Cleveland, Ohio	*Richmond, Va.	Butte, Mont.
Nashua, N. H.	Zanesville, Ohio	Asheville, N. C.	Boise, Idaho
Burlington, Vt.	*Indianapolis, Ind.	Greensboro, N. C.	Casper, Wyo.
*Worcester, Mass.	Decatur, Ill.	Charleston, S. C.	Pueblo, Colo.
*Providence, R. I.	*Peoria, Ill.	Columbia, S. C.	Albuquerque, N. M.
*Waterbury, Conn.	Lansing, Mich.	*Atlanta, Ga.	Sante Fe, N. M.
*Binghamton, N. Y.	*Kenosha, Wis.	*Jacksonville, Fla.	Phoenix, Ariz.
*Syracuse, N. Y.	*Racine, Wis.	Paducah, Ky.	*Salt Lake City, Utah
*Trenton, N. J.	*Minneapolis, Minn.	*Knoxville, Tenn.	Reno, Nev.
*Erie, Pa.	*St. Paul, Minn.	*Birmingham, Ala.	*Seattle, Wash.
Williamsport, Pa.	*Des Moines, Iowa	Jackson, Miss.	*Portland, Ore.
*Wilmington, Del.	St. Joseph, Mo.	*Little Rock, Ark.	*Sacramento, Calif.
Frederick, Md.	Springfield, Mo.	Baton Rouge, La.	*San Diego, Calif.
Hagerstown, Md.	Fargo, N. D.	Shreveport, La.	
*Wheeling, W. Va.	Sioux Falls, S. D.	*Oklahoma City, Okla.	
	Lincoln, Neb.	Austin, Tex.	
	Topeka, Kan.	*Dallas, Tex.	
	*Wichita, Kan.	Wichita Falls, Tex.	

The Changing Years as Seen from the Switchboard

Editor's Note:

The interviews appearing under the above title in current employee magazines of the Bell System are reprinted here, beginning with the first two, as affording an interesting supplement to "Opportunities for Women in the Bell System" which was published in the BELL TELEPHONE QUARTERLY *for January, 1932.*

I. On the Importance of Looking Backward

NUMBER PLEASE? On something like sixty per cent of the 17,000,000 Bell-owned and Bell-connecting telephones which serve America (the sixty per cent connected with manually operated central offices), every local and long distance call is inaugurated by these two words—*spoken by a woman.*

More eloquently than bare statistics, these two words bear testimony to the fact that women play an essential part in the provision of telephone service. If that part were played one whit less intelligently, efficiently and loyally than it is by the 150,000 Bell System women who are engaged in one form or another of telephone work, America's nation-wide telephone service could not be what it is today.

This much is a fact universally accepted by all who know even a little of what goes on behind the scenes of this communication system which links a nation's millions of people and makes them neighbors. Perhaps it is a fact that has become altogether too easily accepted: so easily accepted that it is taken as a matter of course.

How has it come about that women have won their well-earned place in this vitally important national service? Did woman drop into this leading rôle in the telephone drama by

mere chance? Has anybody tried to find out how this composite figure—The Woman of the Telephone Service—became what she is?

Make no mistake about it, those who are responsible for the management of the Bell System have made it their business to trace the long evolution that leads from the first women telephone employees, working at primitive switchboards, to the Bell System woman of today. They could not have done otherwise. They could not do their job today, or prepare for that of tomorrow, without looking long and carefully at what happened yesterday.

That is the way the Bell System has to do things, for telephone service is an unending evolution. One transmitter or receiver gives way to another; a switchboard is developed to meet new needs and displaces another which thereby becomes obsolete; cables are discarded to make way for others of larger capacity or greater efficiency. No Bell System executive or engineer would pass upon the merits of a thing as seemingly simple as a switchboard jack without studying the accumulated experience of those who have designed or made switchboard jacks for the past fifty years. In the provision of telephone service, the only way to look forward is to look also backward.

But telephone service is not merely a matter of mechanisms. It is primarily a matter of manpower. For the purposes of the series of interviews to which this forms the introduction, perhaps one may be permitted to coin a word and say that telephone service is to a very considerable extent a matter of *woman*-power. And properly to utilize the full force of the power that lies in the loyalty, devotion to duty and efficiency of its women, the Bell System has to look not merely at the present, nor toward the future, but also toward the past.

That is why Miss Laura M. Smith, assistant to Vice President E. F. Carter, of the Personnel Department of the American Telephone and Telegraph Company, readily assented when

it was proposed that she submit to being interviewed regarding the contents of certain red-covered, loose-leaf binders which she never allows to be taken far beyond her reach. These books Miss Smith considers very precious, just as any other good workman highly prizes the tools with which his job is done. They contain a mass of data, carefully arranged and digested, which the Personnel Department has obtained from more than 200 men and women who were engaged in the telephone service in its early days: from about two years after the telephone was invented to the first decade of the present century. This information deals, directly or indirectly, with the part which women played in the telephone service during this formative period of telephone history.

"You see," said Miss Smith, opening one of the books, "we wanted a true picture of what the life of the woman telephone employee in those early days really was; and in the very early days, that meant the telephone operator, for there were relatively few other telephone jobs held by women during the first decade or two of telephone history. We wanted to see this picture through the eyes of those who had not merely looked at what took place during those days, but who were themselves actively engaged in telephone work. We wanted eyewitness testimony.

"We had certain concrete things we wanted to find out—how women came to be employed as operators, instead of the boys who first 'manned' the telephone switchboards; what prompted these young women to take up this kind of work; something about the mechanism of the equipment in central offices and about the method of operating it; what was done about training the operators; what kind of working conditions there were during these early years; what the relations of these young women were with the public they served; enough about working hours, wages and a lot of other things to obtain a really accurate idea, to use a modern expression, of what it was all about.

"Whenever possible, we of the Personnel Department here at headquarters got in touch with the individuals themselves and arranged for personal interviews. When this was impossible, as it was in many cases—for these pioneer telephone women were scattered all over the country—we called upon the Personnel Departments of the Associated Companies, and through their co-operation obtained the personal reminiscences of many more operators. When it was impossible to interview these women in person, we sent them a questionnaire or memorandum of the information we hoped they would be able to give us, and they wrote us, giving this information. After the whole mass of material had been collected and analyzed—and in this analysis I had the able assistance of Miss Ruth Currier, of our Personnel Department—it afforded about as complete a composite picture of the pioneer telephone woman as it would be possible, I think, to obtain.

"But that was not enough. We were fascinated by the story that could be told us by the men who, as harum-scarum lads, had been the first telephone operators. We knew we had to get that story, in order that we might have a clear picture of the background against which these first Bell System women were seen as they made their entrance, more than half a century ago, upon the telephone stage. Mr. C. R. Thompson, of the Department of Operation and Engineering of this company, helped us to 'round up' thirty-five or more of these original boy operators. He explained to them the purpose of collecting this material and kept in touch with them until they had answered their questionnaires.

"The information obtained from these former boy operators is—well, if you insist on interviewing me (and I think that, for once, I am going to enjoy being interviewed) you'd better begin with those boys."

Miss Smith was assured that the "boys" in whom she had shown so solicitous an interest would be given first attention. Then she hastened to explain that, even after collecting as

much material as could be obtained from the operators of both sexes, she and her colleagues of the Personnel Department had not been satisfied that the picture they were trying to reconstruct was complete. There were still living a few of the men who had hired these boys and young women, who had watched them at their work, had been responsible for such training as they were given and who, in a vast majority of cases, had known them well enough to call them by their first names. These men also had some testimony to offer that would be valuable, and steps were taken to obtain it.

There still are, incidentally, an extraordinary number of women in the Bell System who may be classed as trail-blazers of the telephone service. At the beginning of 1934 there were 1173 women Bell System employees with periods of service of thirty years or more. Of these, forty-eight had forty years or more of service, and five had been in telephone work forty-five years or more. Retirements have doubtless reduced these totals considerably, but the fact remains that in the telephone business, long periods of service, for men and women alike, are by no means rare.

It is hoped that the present series of interviews with Miss Smith will prove interesting to women who have been long in the service, for all that these interviews are to contain will be based on the eye-witness evidence of pioneers like themselves It is hoped that the younger women, too, will find in the series which begins with this issue something of interest and inspiration. And finally, it is hoped that the older men of the telephone service may find here not a little that recalls the stirring days through which they have lived, and that their younger brothers may feel themselves repaid for reading what may at first seem to be merely another telephone history.

The years have brought many changes, but they have been changes in which all telephone people, men and women, veterans and novitiates, have had their part, working shoulder

to shoulder. There will be many changes in the years that are to come, and they will be brought about in the same way.

II. Those Boy Operators

"Well, what about those boy telephone operators of yours? You know, you promised us a story on what you learned from them about the early telephone days. Have you time to talk about it now?"

We admit that there was a challenge in our voice as we hurled these sentences at Miss Smith. We intended that there should be a challenge in it. We had never thought much of those boy operators. Perhaps our opinion of them had been prejudiced by the writings of the late John J. Carty, who in his early youth had been one of these same boy switch-manipulators in a telephone office in Boston.

"They were very poor operators," he once declared. "They were not old enough to be talked to like men and they were not young enough to be spanked like children. I shall never forget the noise that was made by those young fellows." Some years after this not too commendatory appraisal of the boy operator as he had known him, General Carty, then one of the commanding figures in the telephone world, remarked: "My colleagues of that time were what I think the ethnologists would rank but a little lower than the wild Indian!"

No, we had not thought much of boy operators and we intended that Miss Smith should understand our position, right at the start. Perhaps she did.

"*My* boy operators," she smiled, "I am glad you have put it that way. You know, I can't help feeling a sort of proprietary interest in those youngsters, as they were when they were at the switchboard, in spite of all the criticism that has been heaped upon them. If you read what they have written here—"

Miss Smith interrupted herself to push across the desk one of the red-covered binders which had been the real cause of

all this interview business. We knew from the expression in her eyes that she was getting ready to quote chapter and verse in defense of the boy operators. And she did. With an eager forefinger she pointed to interesting little incidents in the telephone life of a boy who became a telephone "man" in Pittston, Pa., in 1879, at the mature age of thirteen; to others who began at the switchboard a few years later, at approximately the same age, and who, step by step, advanced to positions of high responsibility in the telephone service. One does not have to read far in such a record to come to the conclusion that these boy operators were, after all, a very human lot of individuals who, by and large, made the best of a hard job.

Theirs was a hard job, make no mistake about that. Not because they had to leap from switch to switch with the agility of the monkeys they were; to sweep out the office and keep coal on the fire; to run errands and now and then collect bills or go out to untangle a pair of slack wires which had become wrapped around each other in a high wind—not that. Young muscles are resilient, and so are young hearts and minds. Their job was hard because, when one gets down to essentials, it was a job for which they were not fitted by temperament or training.

It was the most natural thing in the world to use boy operators in the first telephone exchanges. Boys and young men had served as telegraph operators ever since Morse had ticked off his historic "What hath God wrought." So why not put the boys at the telephone switchboards? At the switchboards the boys were put—with just about the same degree of success as attended the attempt to borrow cable and iron wire and even the switchboards themselves from the telegraph business and adapt them to the newly-born telephone art. Like these mechanisms which pioneer telephone engineers tried to fit into the telephone service in its early days, the boy operators served well enough for a while: until something better was found.

What was found, of course, was the woman telephone operator. But that is another story.

Miss Smith swiftly turns the pages of the red binder, pointing to notes on interviews with these men who in their youth had been the first guardians of the Bell System's switchboards, or to their answers to a questionnaire which the Personnel Department had sent them. As she comes to some particularly interesting or significant point, she stops to comment on it, almost as if thinking out loud.

"You know," she says, earnestly, "since collecting this material and studying it, one thought has recurred to my mind again and again. We call these people—the men and women and the boys of the first years of telephone history—'pioneers.' I wonder whether we stop to think how true a description this is of what they were? When we read what they—the boy operators and the women operators alike—have written here, we see very clearly that they were actually living and working amid pioneer conditions. They were blazing a trail and pushing forward a frontier, just as did the men and women who settled the West.

"They worked with communication equipment as relatively crude as were the prairie schooners that creaked their way across the prairies and over the mountains to the Pacific. They worked long hours and had to face a thousand obstacles. They had to keep constantly on guard against discouragement. But they kept on.

"I suppose we of this day can have no conception of how crude, as compared to modern telephone apparatus, the switchboards of that day were. See what this former boy operator says about the equipment at which he began work:

> Our switchboard was a wonder. It looked like a cross between an oldtime telegraph switchboard and a bread toaster. The "indicators" were a number of ordinary bell boxes of different sizes and were fastened to the wall directly over a Blake transmitter. The tone of each and every bell was exactly alike,

> and I was in receipt of many complaints for slow answers because of the difficulty I had in finding which bell rang whenever I was called.

"Outside plant," Miss Smith continues, "was no better than central office equipment, and sometimes the boy operators had to do double duty, taking care of minor troubles with the lines. This same boy describes one method, apparently original with himself, of dealing with outside plant trouble:

> Because of the small amount available for the purchase of poles, it was necessary to be saving of them, with the result that our construction gang in planting poles made the distance between them as great as the strand of wire would permit. It was only natural, therefore, that two parallel lines swinging between poles 300 feet apart would become "crossed" by every strong gust of wind. When this happened I followed the course of the line out of town with a wagon spoke in my hand, and on reaching the point of trouble, a well-aimed throw of that wagon spoke knocked out the "cross." Then, walking back to town, I would resume business.

"You see, don't you," Miss Smith asks, "what I mean when I say that these boys were working under pioneer conditions —in the 'prairie schooner' stage of telephone development?"

There are scores of instances which prove that the boy operators of these early days of the telephone developed, of necessity, an initiative and a resourcefulness in dealing with unexpected difficulties: the pioneer's characteristic knack of adapting himself to circumstances. When switchboards refused to function properly, these lads transformed themselves into telephone engineers and created some sort of make-shift with which to deal with the difficulty.

In the moments of leisure between calls—for traffic was often light in those days—these youngsters often occupied themselves with amusements that are also suggestive of pioneer days in the far West. There was something of the cowboy in them all, and the pranks they played upon each other and,

it must be admitted, upon subscribers, had an abandon about them that often approached boisterousness.

Some things, however, they took seriously. When they had to report to a subscriber that a line he wanted was busy, they expected themselves to be believed. If their word was doubted, as it not infrequently was, there was an exchange of amenities over the wire which often involved a short and ugly noun and sometimes an almost as short and even uglier adjective. There were reciprocal threats of punched heads and other bodily injuries and, now and then, an overt act of physical combat. They were a virile lot, those boy operators.

But, in spite of their pranks and their two-fisted assertion of what they conceived to be their rights, their subscribers liked them. Once more after the fashion of pioneers, there was a free and easy relationship between these youngsters and young men and the public they served. Subscribers were constantly calling upon them for services which today would be far outside the limits of a telephone operator's duties, and these services they cheerfully performed.

Doctors who left their offices expected the operators to keep track of the sources of incoming calls during their absence, so that they might call back when they returned; heavy sleepers gave orders to be called at a specified time each morning; business and professional men wanted errands run. Here, for example, is a paragraph from the reminiscences of one of the New Jersey boy operators:

> It was the custom of some of our big men to telephone from New York to the Bayonne operator and say "Tell Barney to meet me on the 11:30." The business then was for the operator to shout out through the window across to the station cab man: "Hey, Barney, meet Mr. A. on the 11:30." Subscribers making such requests invariably added, "I'll fix you up for this some time." Fixing, however, never took place.

Miss Smith closed the red-covered binder and handed it to the writer for further study.

"Be sure to bring it back," she said. "You'll find a lot of interesting things in it—too many to put in one interview, I'm sure. But I venture to say you will find nothing more interesting or significant than what these men who were boy operators have said about the job they did, as compared with the way that same job was done, after they had left the switchboard, by the women who took their places. You'll find a lot of things like this—"

She reached for the binder again, opened it and pointed to these words:

> As much as boys thought of their ability as operators, it is my opinion that even though boys had had the same systematic training as received by female operators, the boys would rate a poor second best. The boys perhaps were able to stand more wear and tear in the distant past hurly burly traffic conditions. They were, however, in the habit of following their own operating practice and assuming their own responsibilities. . . . I believe it would be difficult for boys ever to fall in line with the present day efficient operating practices which seem to come so easy to the female operators.

This analysis, presumably unprejudiced, since it is from the pen of one who himself had been a boy operator, provides the explanation of the disappearance of these lads and young men from the telephone central office. One by one they went their way, except in such rare instances of group displacement as occurred in Scranton, Pa., when half a dozen boys quit the switchboard to celebrate St. Patrick's Day and found, to their chagrin, that their jobs had been taken by girls when the celebration was over. By the late 'eighties, girls were operating practically all Bell System switchboards during the daytime. There are still a few male night operators in small, outlying offices of some of the Bell System companies. The use of boys and young men as night operators was fairly common, even in the larger cities, until as late as 1903 or 1904, for it was not until the present century was well under way that it was uni-

versally considered quite safe or proper for a girl to take a job that involved being away from home after dark, even if she could do that job better than a man.

That not a few of these lads possessed large amounts of potential ability is evident from the fact that many of them went into other branches of telephone work and that, of these, some rose to high positions of responsibility as leaders in the telephone service. But whether they went on to these higher rungs of the ladder or not, they served their purpose while they were at their switchboards. They were pioneers, with the virtues and sometimes the small vices that go with the pushing forward of frontiers. Harum-scarum little curmudgeons though some of them were, they wrote an important chapter in the history of communication. They helped to build a nation-wide telephone service.

R. T. BARRETT

(*To be continued*)

International Radio Technical Committee Meeting of Libson, 1934

AN international radio conference of some general interest was held last fall at Lisbon, Portugal, by the International Radio Consulting Committee, commonly termed the CCIR.

There is given in what follows, first, an indication of the problem which occasions meetings of this kind and of how the world coördination of radio is being effected, and, second, an outline of what happened at the Lisbon Conference itself.

Radio may be likened to a huge, carrier current, multiplex system with the common "line" medium shared throughout the world by radio services of various types and nationalities. The multiplicity of channels which go to make up this multiplex system requires coördination if general interference is to be avoided. The situation is helped by the fact that not all the radio channels are intercontinental in their effect. A degree of uniformity in the uses to which the waves are put follows from the fact that the waves in the different frequency bands have much the same physical characteristics throughout the world and tend naturally to be put to similar uses. A certain fitting together of the channels is accomplished on a more or less trial and error basis by the various operating agencies of the world as the channels come into use. But obviously a more ordered arrangement and procedure is desirable, requiring definite world understanding.

World Regulation

The general coördination of radio channels has been accomplished by a world agreement which covers the general blocking out of the frequency spectrum to the different services and

certain general principles concerning the obligation which the nations have of avoiding interference. Such agreement has been reached through general international conferences, such as those of Washington, 1927, and Madrid, 1932, and takes the form of a convention or treaty. The convention now in force in the United States is that of the Madrid Conference of 1932, which constitutes the general frame within which the radio channels of the world are allocated. Actually, the Madrid Convention covers in a general way all forms of electric communications, but the United States Government's interest applies more particularly to radio because of the subject of frequency allocation and interference.

The making of a fairly full use of the radio medium without interference is dependent upon much more than the *general* regulation of frequency allocation. It is dependent, in the first place, of course, upon the more fundamental technical advance of the art which determines the extent to which the frequencies can be held constant and the channels can be segregated by a sharp frequency cutoff in the transmitting and receiving apparatus. It is dependent also upon such factors as the propagation characteristics of the waves, the geographical separation between stations, the relative power levels between channels, etc. Our knowledge concerning these factors comes, of course, primarily from the laboratories and operating plants within the different nations. This knowledge is rapidly spread throughout the world through the technical press. It is, however, desirable that the state of the art be reviewed from time to time and a consensus drawn as to what constitutes reasonably good engineering practice in respect to these technical matters. It is this which is done in international advisory conferences of the kind which was held by the CCIR at Lisbon. While the findings of such a conference are purely advisory, they have the weight of a world consensus.

In addition to the radio advisory committee, there are in existence two other advisory committees, one a committee on

international wire telephony (CCIF) and the other, a committee on international wire telegraphy (CCIT). The radio committee contrasts with the wire committees by being more formal and diplomatic in character. This is because its work is concerned so largely with the technical coördination of frequencies in the common radio medium and affects the military as well as the civil establishments of the nations. The international problems involved, evidently, are largely matters of governmental interest. The telephone advisory committee, on the other hand, is largely a matter of interchange of information and of determining reasonable standards for technical practices as among the telephone operating agencies. This is of particular importance on the continent of Europe in facilitating the interconnection of circuits of the different countries and the building up of an adequate toll system throughout that continent. The recent work of this telephone committee was outlined in the October, 1934, issue of the BELL TELEPHONE QUARTERLY. The telegraph advisory committee is of much the same character as the telephone committee.

RADIO TECHNICAL ADVISORY CONFERENCES

The Lisbon Conference constituted the third meeting of the CCIR since its formation in 1927. The two preceding meetings were concerned largely with putting order in the high-frequency (short-wave) bands. The first of these, held at The Hague, had set up as a general guide that the different nations of the world, in making wave-length assignments in the high-frequency range, should do so, so far as possible, on frequencies which are multiples of 5 kilocycles, this as a simple way of insuring some spacing of the channels. The second meeting, held at Copenhagen, rather specialized on radio transmitters and set up some limits to which the frequencies of transmitters should be held. The recent Lisbon Conference may be said to have made a beginning in considering radio as a *system*, for it studied questions of the suppression of undesired components at the

transmitting station, of propagation through the transmitting medium, and of characteristics of receiving sets.

To the Lisbon Conference the United States Government sent five delegates: one each from the Departments of State, Commerce, Navy, Army, and from the Federal Communications Commission. The delegation was headed by Dr. J. H. Dellinger, Chief of the Radio Section of the Bureau of Standards. Several of the United States operating agencies sent representatives, including RCA, Mackay Radio and National Association of Broadcasters. The Bell System was represented by Lloyd Espenschied and R. A. Heising, of the Bell Telephone Laboratories. The questions which were to come before the conference were studied in some detail beforehand in Washington in joint government-company committees.

Outcome

The general findings of the Lisbon Conference may be summarized as follows:

In the first place, it should be mentioned that European broadcasting seemed to be uppermost in the minds of the majority of the delegates and most of the technical questions were studied with this subject as a background.

A rather general interest was displayed also in the subject of radiotelephone service to small vessels, particularly fishing vessels in the North Sea. To care for a serious interference situation which had grown up in that area, the European nations most directly concerned drew up, outside the CCIR, a regional agreement constituting a channeling system for that service. The CCIR formulated a more general recommendation upon the subject of small-boat telephony, touching upon such factors as the need for high-frequency stability and for high receiver selectivity.

After much study, there was drawn up a set of propagation curves of signal field strength versus distance, for the range of frequencies involved in broadcasting (150 to 1500 kilocycles),

including European long-wave broadcasting. These curves have taken advantage of earlier work done in Europe and America and are perhaps the most authoritative of their kind in existence. Their principal usefulness is in estimating interference effects between broadcasting stations, particularly as between stations sharing the same frequency.

The way in which the quality of program transmission increases with the width of the frequency band transmitted was set forth in its bearing upon the frequency spacing which it is necessary to maintain between radiobroadcast stations.

The extent to which it is practicable to suppress the harmonics of radio transmitters was gone into and some limits were adopted which should be generally useful. There were not, however, sufficient data available to enable the subject to be covered very completely, and it is to receive further study at a future meeting.

The subject of receiving set selectivity was studied, having in mind its relation to the frequency spacing of radio channels. A mass of selectivity curves which had been presented showed that wide variations exist in receiving set selectivity and also that there was need for the further development and unification of measuring methods. The subject was put up for continued study on this basis.

The strength of the field which it is necessary to receive for the different services, in relation to noise as a fundamental limiting factor, was a subject of active interest. A certain amount of data had been collected on the field strengths now actually being used in the various services. The subject of noise and its method of measurement and evaluation were gone into. The whole subject of field strength and noise level was put up for further study.

Considerable interest was shown in the possibility of using for broadcasting single sideband with carrier transmission (i.e., one sideband eliminated). Some field tests of this method of transmission had been made in Holland and in England just

prior to the Lisbon Conference, and the whole subject was under active discussion in Europe. The conference did not find it possible to come to any final opinion but merely recommended that the experimental development of the subject be continued.

The question of the interference with radio reception, particularly with broadcast reception, which is experienced from man-made electrical sources, was discussed rather fully. This type of interference is local and not of international effect, and might be expected to be handled on a national basis. The European administrations, however, desire to handle the subject internationally as a means for obtaining uniformity in the noise suppression devices and practices to be applied. They anticipate legislation in the various countries of Europe and desire that the requirements placed upon manufacturers for electrical equipment, for example, be uniform throughout Europe. The subject is to be studied further in relation to the work being done by the International Electrotechnical Commission.

Difficulties

Naturally, the world does not get together in conferences of this kind without some difficulty, and a glance at this side of the picture will help to give a balanced perspective of the whole situation. In the first place, there are the difficuties of procedure, the problem of handling complicated technical questions in a large and rather formal gathering of delegates (there were some 160 at Lisbon), having quite different viewpoints and different native tongues. To an American the language difficulty is particularly troublesome. At Lisbon, English as well as French was used on the conference floor, with verbal interpretation given from one to the other, but all of the conference papers were in French. These were translated into English as rapidly as possible by the United States Government delegation, but frequently action was taken upon texts before the English rendition was available.

Perhaps the greatest difficulty from the standpoint of the United States resides in the fact that the European conditions differ so substantially from those in North America. The close proximity of the nations in Europe renders unusually difficult the sharing of the radio medium and tends to project into the international category problems which on the American side would be handled nationally or, at least, in a less formal regional manner. Examples of such problems are those of broadcasting, small-boat telephony, and interference with broadcast reception from man-made sources. The representation at the conferences being that of nations, rather than one of world regions or of communication development, gives to these conferences a great preponderance of European delegates and tends naturally to render them in large part European regional meetings. The difficulty presented to the United States' participation is not unlike that of the League of Nations. Nevertheless, the United States has taken an active and constructive part in these meetings, real progress has been made, and radio is perhaps an outstanding example of the attainment of a large measure of world agreement.

The Host Country

Portugal, land of the early navigators, provided a haven for the Lisbon Conference which the attending delegates will long remember as well suited to the practical purposes and delightful in its setting. The meeting place was at Estoril, a resort on the Coast of the Sun, some fifteen miles west of Lisbon proper. Several extended trips into the interior of the country, arranged by the reception committee of the Portuguese administration, gave the delegates a glimpse of a land of unusual interest in respect to its background, its beauty and present evidence of prosperity. It is truly a land of grapes, affording a spectrum of wines as interesting as the radio frequency spectrum which was under study!

The picture of this conference would not be complete without reference also to one of the mainstays of it, namely, the Berne Bureau. This is the centralizing body which carries out the secretarial and interpreting side of the meeting. Its work was excellent. Most unfortunately the head of the Bureau, Dr. Räber, passed away within a few weeks of his return to Switzerland.

One little highlight which might be added was that the Russian Soviet delegation was detained at the border and was not admitted to the conference by Portugal.

When the conference adjourned, the members found themselves, in effect, upon an island because the political disturbances in the adjacent country of Spain prevented return over the usual overland route. As a result, the delegates left Portugal by sea, a mode of travel not inappropriate to the traditions of the host country, nor to the early beginnings of radio itself.

LLOYD ESPENSCHIED

Notes on Recent Occurrences

TELEPHONE SERVICE EXTENDED TO JAPAN

TELEPHONE service with Japan was formally opened on Friday, December 7, 1934, thereby reducing to three the important telephone systems of the world with which the United States does not now have voice contacts. Only Russia, China, and New Zealand remain out of reach.

Interesting ceremonies inaugurated the service. In Washington, D. C., it was about seven o'clock in the evening of December 7, while in Tokyo it was nine A.M. of the following day, when Secretary of State Cordell Hull, Chairman Eugene O. Sykes of the Federal Communications Commission, and other government officials, and Vice President Arthur W. Page of the American Telephone and Telegraph Company, exchanged greetings with Foreign Minister Koki Hirota, Mr. Seichi Shindo, Director General of the Japanese Telecommunications Bureau, and other government and telephone officials in Japan.

In opening the ceremonies Mr. Page spoke as follows to Mr. Shindo:

"Good evening, Mr. Shindo. Mr. Shindo, this is Arthur Page of the American Telephone and Telegraph Company. We are in the office of the Honorable Cordell Hull, Secretary of State, who is present, as are also His Excellency Ambassador Saito and Judge Sykes, Chairman of the Federal Communications Commission. I am glad to have the opportunity at this opening of service of extending greetings from the Bell System to the Telecommunications Bureau of the Government of Japan and to assure you that we look forward to a long and happy association in which, we trust, we can together usefully serve the people of the two nations."

To this Mr. Shindo replied:

"We are assembled at the Tokyo Central telephone office. I have the honor to announce the presence of His Excellency Minister Tokonami, and their Excellencies Minister Hirota and Ambassador Grew. There are also present high officials of the Ministries of Communications, Foreign Affairs, prominent business men, and representatives of the news agencies. Mr. Page, this is Mr. Shindo, Director General of Telecommunications of the Ministry of Communications. Thank you for your kind greetings, which I heartily reciprocate. Please be assured that we are also looking forward to a long and happy association in which we trust we can together mutually serve the peoples of the two nations."

Mr. Takejiro Tokonami, Japanese Minister of Communications, then spoke with Judge Eugene O. Sykes, saying:

"Please accept my hearty congratulations on the opening of the radiotelephone service between Japan and the United States.

"The friendly relations between the two countries, as you are aware, date far back from the middle of the 19th century, when your Commodore Perry first came over to Japan on a special mission with the result that Japan, after closing herself to foreign intercourse, opened her door. Since then, the intercourse between the two countries has made rapid progress. Harmonization of civilization of the two resulted in mutual understanding and friendly relations, and at last have become the two great neighboring countries bordering the Pacific Ocean. Just at this moment it is very significant that a radiotelephone link has been established between Japan and the United States. This new service, I believe, will make cultural and economic ties of the two countries closer and closer and develop our traditional friendship to a great extent.

"I earnestly hope that this radiotelephone service will widely and freely be used, its functions be displayed to the

fullest degree and thus contribute to promote the welfare of and friendship between the two peoples."

Judge Sykes' response was as follows:

"It is indeed a pleasure to talk with you upon this momentous occasion of the opening of the direct radiotelephone communications between your great capital and ours. This is but another marvelous achievement whereby our nations are brought closer together and should further promote the cordial relationships existing between these countries.

"I must refer, with a great deal of pleasure, to the sincere co-operation which has always existed between your delegations and ours to International Radiotelegraph Conferences. We very much appreciate this cordial relationship and feel sure that it will continue in the future.

"May I personally wish you the best of luck and congratulate you upon your administration of communications in your great and beautiful country."

The next conversation was between Secretary of State Cordell Hull and Mr. Koki Hirota, Japanese Minister for Foreign Affairs. Mr Hull said:

"Mr. Hirota, this is Mr. Hull speaking. I am very glad to have this opportunity of greeting you directly and by voice, and it is a source of gratification to me to participate today with you in the inauguration of direct radiotelephonic communication between the United States of America and Japan.

"Eighty-one years have passed since the first official communication took place between our two countries. In 1853 a message sent by President Fillmore and credentials signed by Mr. Everett, then Secretary of State, were delivered to officials in Japan by Commodore Perry. The voyage from the United States to Japan occupied more than seven months.

"During these eighty-one years the physical world has been made smaller by the ingenuity of man. Science has included space in the list of its conquests. Whereas in 1853 the delivery of a message from America to Japan required months of

labored travel, today the officials and nationals of our respective nations are able to talk to each other across the world.

"It is a common observation that in the measure that people enjoy personal contact with one another, so do the barriers which separate them dissolve. This new means of communication which we inaugurate today spans the wide ocean as an additional link between our peoples. It is my hope that by furthering the interchange of ideas and of commerce which play so important a part in the relationship of states, radiotelephone service will be of great and mutual benefit to our two nations."

To Mr. Hull's remarks Mr. Hirota made the following reply:

"I am exceedingly happy to express my sincere congratulations upon the inauguration of the radiotelephone service between America and Japan and to reciprocate the spirit of cordiality in which you have just spoken.

"To meet the demand arising from the constant progress of the economic relations between our two countries, the institution of this kind of communication system across the Pacific Ocean has long been desired. The work required ardor, courage, and endurance. Today it is proper that due honor should be given to those who have achieved this difficult task which marks a new era in the good relations between our two countries.

"This occasion touches me deeply, since I can hear you personally through this apparatus. As I take my part in this friendly exchange of sentiments, I feel confident that this system of communication will prove to be a novel means for the promotion of understanding and good-will.

"Science knows no bounds in its progress. The time will soon come when telephone will work hand in hand with television, so that not only shall we hear each other's voice but also see each other's face. If this vision be translated into reality, distance would be almost annihilated, to the further en-

hancement of the intimacy which characterizes the relationship of our two nations.

"May I express again my hearty felicitations to you, and through you to the people of the United States, on the opening of this new communication service between America and Japan?"

When Mr. Hirota finished speaking he made way for Mr. Joseph C. Grew, American Ambassador to Japan, who talked informally with Mr. Hull. Mr. Hiroshi Saito, Japanese Ambassador, took Mr. Hull's place at the telephone in Washington and exchanged greetings with Mr. Hirota and Mr. Grew. The American Ambassador also talked with his daughter, Mrs. J. P. Moffatt, who was one of the guests at the Washington gathering.

At the conclusion of the Washington end of the formalities, the connection was switched to the office of Vice President T. G. Miller of the American Telephone and Telegraph Company in the Long Lines building in New York. With Mr. Miller acting as master of ceremonies, the heads of American press associations and several American correspondents of Japanese newspapers conversed with newspaper executives and correspondents in Tokyo.

Telephone service between the two countries was made available to the public on December 8.

The circuit to Japan uses the same facilities in this country as those which give service to Hawaii, the Philippines, and the Netherland East Indies. The terminals are at San Francisco and Tokyo, with short wave radio channels in the band between 18 and 45 meters bridging a distance of 5,100 miles. The area in Japan which can be reached includes the island of Hondo, which contains most of the principal cities, and Nagasaki, on the island of Kyushu, embracing in all some 380,000 telephones. All Bell and Bell-connecting telephones in the United States, Canada, Cuba, and Mexico can be linked with Japan through this new radiotelephone circuit.

Japan is the sixtieth foreign country to be brought within voice range of the United States, and the new radio channel is the seventeenth direct radio telephone circuit between American Telephone and Telegraph stations and overseas points. The Bell System transmitting station at Dixon, Cal., not far from San Francisco, focuses on the receiving station at Komuro, near Tokyo, by means of a highly directional antenna, while the circuit in the opposite direction reaches the Point Reyes, California, receiving station from Nazaki.

DEATH OF THOMAS A. WATSON

THOMAS A. WATSON died at his winter home, Passagrille, Florida, on December 13, in his eighty-first year. It was he who helped Alexander Graham Bell with the latter's experiments leading to the invention of the telephone; who made Bell's various experimental instruments, including the one which first transmitted intelligible speech; who heard Bell's voice speaking the first complete sentence ever transmitted over the telephone. With Mr. Watson's death there passes the last individual who was intimately connected with the invention of the telephone.

The following tribute by William Chauncy Langdon, Historical Librarian of the American Telephone & Telegraph Company, appeared in all the employee magazines of the Bell System:

THOMAS A. WATSON
1854–1934

To all telephone people Thomas A. Watson has represented the personal tie that bound them with the very beginnings of their great family. Now that he has gone and we consider his life as a whole, it becomes more and more clear that the title of his autobiography, "Exploring Life," was indeed the characteristic of the man throughout his eighty-one years. Born

January 18, 1854, the son of Thomas R. Watson, the foreman in a Salem livery stable, and of Mary Phipps, his wife, from the beginning all paths, all ideas led out into a wonderful and unknown world. He died December 13, 1934, in the evening, at Passagrille, Florida, where so often the westering sun as it set in the Gulf of Mexico led his mind and imagination ever on into the infinity of a wonderful and glorious universe.

From the day of their marriage in 1882, indeed from the time of their first meeting, Dr. and Mrs. Watson were one in their interests, whether of work or of recreation, of education or of community welfare. Whatever opportunity opened before them, it was a path that they followed together. It was sure to lead out into new wonders, into new life. Always eager and determined to see what lay beyond, and to learn: that was the spirit of the man from childhood. And Mrs. Watson was always with him, in the fullest sense of the word, a true companion.

The Quality of His Mind

Young Watson was always ready for the new opportunity. As an apprentice in the shop of Charles Williams, Jr., he always kept his tools cleaned and sharpened and in order. As a young mechanic working with Alexander Graham Bell, he kept in his notebook a list of the books in the Boston Public Library that contained information about electricity with their shelf numbers, so that he need lose no time in using them for reference. When he went up to North Conway, New Hampshire, in December, 1876, and for the first time saw snow-covered mountains, he responded to the sight with all the enthusiasm with which he gave himself to work. It was the beginning of his life-long passion for mountain climbing.

It all centered in a quality of his mind, a certain precision, which accounted for his remarkable memory and made his assistance invaluable in recording and checking the history of the early days of the Telephone. Work and study and recreation alike were to him "exploring life."

It is, fortunately, unnecessary to relate the story of Dr. Watson's life. It may be read, much of it, told with all his human interest and delightful simplicity, in his autobiography. That he was the trusted assistant of Alexander Graham Bell, before, during and after the invention of the telephone; that it was he who heard the first words spoken over the telephone, and that he with his own hands made the first telephones—these facts are familiar to all telephone people. That after Mr. Bell went to England in August, 1877, he struggled on alone with the technical problems of the new communications service, is known to his successors, the telephone engineers of the present.

Though he left the telephone service more than fifty years ago, he still followed with keen interest the work of the men and women of the telephone, indeed more and more as the years went by. Every time he came to New York he asked what was being done at the Laboratories and on every one of his frequent visits to the Laboratories he showed a thorough understanding of their problems and appreciation of each new development. At the Century of Progress Exposition in Chicago last year he wanted to see everything in the Bell Exhibit in detail. It was *his* exhibit. So too with the Sesquicentennial Exposition in Philadelphia in 1926. Many a time has he expressed to me his admiration and wonder for the work of the telephone family.

His Wide Range of Interests

Perhaps, however, there are few who realize the wide range of his interests. He did not go to school after he was thirteen years old until he was forty. Then he and his wife went together to the Massachusetts Institute of Technology. At this time he began the study of geology, which like all his other pursuits continued a life-long interest. In this he attained the recognition of professional scientists.

Returning in 1881 from a year in Europe, he started a machine shop and built an engine. Out of this grew the Fore

River Ship & Engine Company. Here occurred an outstanding instance of his predominant concern for his fellow men. In the depression of 1893 he deliberately increased his shipyards and moved down to deep water so that he need not lay off any of his men but could give work to others of "his neighbors," although he knew he was risking his business and his fortune. It was then that he built a large part of the U. S. Navy of the Spanish War.

He believed in education actively. He started kindergartens for his community and personally served on the local school board. Even in politics he thought there was good. Into the study of economic and political theory he went as an explorer, not confining himself to the traveled roads, but boldly striking across where he thought might lie the right direction. As an explorer he joined whole-heartedly the Socialist party and ran for local office on their ticket.

Explorations in Culture

As in mechanics and in business, in manufacturing and in science, so in matters of culture. What could literature and music teach him about this life? In June, 1875, when Bell tested the first telephone, Watson could not use his voice well enough for Bell to hear him. Bell started him in the cultivation of his voice, and long years since his voice and his use of it had reached the quality of a musical instrument. He used this ability to speak in public readings and lectures. Naturally, the story of the invention of the telephone told by Dr. Watson himself was in great demand. In response to this demand Dr. Watson delivered as a lecture hundreds of times to schools and other audiences the substance of his pamphlet, "The Birth and Babyhood of the Telephone."

With this study of elocution he naturally developed an intense love for literature, especially poetry and the drama. The works of Shakespeare, Robert Browning, Emerson, and Walt Whitman he knew intimately. In 1910, hearing that Frank R.

Benson, the noted English actor-manager, took students into his company, Dr. Watson applied for the opportunity, was accepted, and at the age of 56 went behind the scenes for the first time in his life. By the end of the season he was given speaking parts at the Shakespeare Festival at Stratford-on-Avon. And Benson never knew that this charming and surely eccentric American was Watson of the Telephone and the great shipbuilder. Then only a few years ago he took up painting, and explored life through that art, learning to see more of the significance of life as expressed in the beauty of land and sea.

To all these he added Philosophy as the highest of his interests, and as the essence of them all. His painting was closely allied to this, for the creative light of the sun was to him a favorite illustration for the divine source of all life. Even from boyhood the metaphysical was fascinating to him. As he grew and disciplined his thinking with the positive interest of scientific subjects, he clarified his thought. Religion was to him a matter of practice rather than of theology. He kept his ideas foot-free, but religion and philosophy are closely akin. While he did his own thinking, he eagerly assimilated the thought of others. Within the last year or so, Spinoza especially was an inspiration to him. To the beatific vision of the thinker of 300 years ago Dr. Watson brought his considerable familiarity with modern science, and with his insatiable instinct for exploring life made his own progress toward the Truth.

"The Sun Shines Beyond"

This tribute to Thomas A. Watson cannot close better than with what he said about the day when he received word of the passing of Alexander Graham Bell:

"The summer of 1922 marks, perhaps, the last important epoch in my life. My wife and I spent that summer in the Colorado mountains. Toward the end of our stay there, we made a long excursion without a guide through some of the high valleys and passes of the beautiful region of forests and lakes,

near Long's Peak. Mountains have always reminded me of my telephone days, probably because my first sight of them was so impressive on the notable day I spent in North Conway, New Hampshire, in December, 1876, when I talked with Alexander Graham Bell in Boston over the first long line on which we had tried the telephone.

"Those superb Colorado peaks surrounding us on our walk brought back my telephone life with strange vividness. Every incident of the walk seemed to remind me of some telephone experience. Sunshine and storm, level stretches and hard climbs, smooth trails and rough trails, the fresh energy of morning, the fatigue of evening, even the flowers by the wayside—each and all tallied something in those days of my telephone work.

"And, as if foreshadowing the final act of a drama, toward evening of the last day of our excursion a dense cloud swept down on us. It made us lose the trail and we wandered for hours without finding it, when suddenly the cloud lifted and we emerged into sunshine again with our camp close at hand.

"When we reached our cabin that cloud took on a strange significance, for lying on my table was a telegram announcing the death that morning of Alexander Graham Bell, sent me by his wife. Our walk through the mountains had been the noble prelude to the coming of that message.

"And with my sorrow for the passing of the man who had meant so much in my life came a sense of loneliness as I realized I was the last of the little group so closely and happily associated in our telephone struggles and successes nearly half a century before.

"It cannot be long before I must follow my old associates into the cloud, but I have faith that the sun shines beyond."

But in the intervening years he came to think less of the cloud and more of the sun. The glories of the sunset over the sea filled his mind. And now the sun is setting at Passagrille.

NEW RECORDS IN OVERSEAS TELEPHONE HOLIDAY TRAFFIC

Nineteen Thirty-five's New Year greetings to foreign lands by telephone reached the highest figure in the history of the Bell System's overseas service. A total of 172 conversations were handled on New Year's Eve and New Year's Day at the foreign service switchboards in New York, San Francisco and Miami, uniting American subscribers with friends and relatives in Palestine, South Africa, Japan and many other distant lands.

The New Year's traffic brought the grand total for the two perennial peaks at Christmas and New Year's to an all-time high. During the four days comprising these holidays a total of 565 calls were completed, against 509 the year before. Four hundred and seventy of the calls were through New York, where the traffic showed an increase of 12 per cent from the record of 415 established last year.

Americans again appeared more telephone-conscious than people abroad, a majority of the calls being outward. A number of long conversations were held, one of them lasting for 40 minutes.

A large proportion of the calls across the Atlantic were to London. Paris and Rome also had a substantial number of calls. "Christmas traffic" actually began on Christmas Eve, as some American subscribers discovered upon receiving calls from the Far East, where Christmas Day arrived fourteen hours before it reached New York.

While comparatively few ships were on the high seas over the holidays, a number of calls were handled with ships. On New Year's Eve alone 27 conversations were held with the Monarch and Queen of Bermuda, Ile de France, Europa and Aquitania. Other ships which had traffic during the holidays were the Empress of Britain and the Olympic. In some cases the ships were practically in New York harbor, in others they were half-way across the Atlantic.